

Exhibit E

UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF NEW YORK

UNITED STATES COMMODITIES FUTURES
TRADING COMMISSION,

Plaintiff,

-against-

DONALD R. WILSON AND DRW
INVESTMENTS, LLC,

Defendants.

Civil Action No.: 13 civ 7884

ECF CASE

EXPERT REPORT OF JEFFREY H. HARRIS, Ph.D.

JULY 27, 2015

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I. ASSIGNMENT

1. I understand that the Plaintiff, U.S. Commodity Futures Trading Commission (“CFTC”), has alleged that Defendants, Donald R. Wilson, Jr. and DRW Investments, LLC (“DRW”),¹ illegally placed orders for a futures contract known as the IDEX USD Three-Month Interest Rate Swap Futures Contract (the “Three Month Contract”)² to influence settlement prices³ in their favor, thereby increasing the value of their portfolio and illicitly gaining a profit at the expense of their trading counterparties.⁴
2. I have been retained by Kobre & Kim, LLP, counsel for Defendants, to assess whether DRW’s bids reflected legitimate supply or demand for the Three Month Contract, whether the Three Month Contract’s settlement price prior to the bids at issue reflected legitimate supply or demand for the Three Month Contract, and whether DRW’s profits on the Three Month Contract were impacted by the at issue bids. In addition, I have been asked to review and respond to certain opinions expressed by CFTC’s expert, Mr. Robert M. MacLavery, in his report (the “MacLavery Report”) filed in connection with the current matter.⁵
3. More specifically, I have been asked to:

¹ In this report, I use the term “DRW” for the entity DRW Investments, LLC unless noted otherwise.

² Complaint for Injunctive and Other Equitable Relief and for Civil Monetary Penalties under the Commodity Exchange Act in *United States Commodity Futures Trading Commission v. Donald R. Wilson and DRW Investments, LLC*, November 6, 2013 (hereinafter the “Complaint”), ¶2.

³ The “price” of the Three Month Contract is expressed as the interest “rate” of the fixed leg portion of the swap (See Complaint ¶2 and Rules of International Derivatives Clearinghouse, LLC, As of September 1, 2010, IDCG0010640, p. 99 (hereinafter “IDCH Rulebook”)). In my report, I use the terms “price” and “rate” interchangeably depending on the context to facilitate the comparison between the Three Month Contract and non-cleared over-the-counter interest rate swaps, which are quoted in rates.

⁴ Complaint ¶1.

⁵ Expert Report of Robert M. MacLavery, Prepared at the Request of Plaintiff United States Commodity Futures Trading Commission in *United States Commodity Futures Trading Commission v. Donald R. Wilson and DRW Investments, LLC*, June 19, 2015.

- a. Provide a description of over-the-counter interest rate swaps ("OTC interest rate swaps") and cleared interest rate swap futures contracts;
- b. Provide a description of central clearing and explain how cash flows from variation margin affect the value of cleared interest rate swap futures relative to non-cleared OTC interest rate swaps;
- c. Provide a description of the Three Month Contract, the interest rate swap futures contract at issue in this matter;
- d. Provide a valuation of the Three Month Contract and opine on the analysis and findings presented by Cont *et al.* (2011);⁶
- e. Provide a description and analysis of DRW's bids on the Three Month Contract;
- f. Provide an explanation of price discovery in the context of the current matter;
- g. Opine on CFTC's allegations of market manipulation and illicit profits; and
- h. Review and respond to certain aspects of the MacLavery Report.

II. SUMMARY OF OPINIONS

4. Based on my review of available information, I have reached the following opinions and conclusions:

- a. The rates that represent fair value on the cleared Three Month Contract are higher than rates on non-cleared OTC interest rate swaps with similar terms due to cash flows from daily variation margins applied on the cleared Three Month Contract. These higher rates stem from interest rate volatility and an upward sloping yield curve over the term of the swap.
- b. The difference in value between a cleared instrument such as the Three Month Contract and a non-cleared instrument such as an OTC interest rate swap with similar terms is commonly referred to as the net present value ("NPV") effect and/or the convexity effect,⁷ which are widely accepted features of centrally cleared interest rate derivatives.

⁶ Cont, Rama, Mondescu, Radu, and Yu, Yuhua, "Central Clearing of Interest Rate Swaps: a Comparison of Offerings," March 11, 2011. Available at <http://ssrn.com/abstract=1783798> (hereinafter "Cont *et al.* (2011)").

⁷ Also known as "convexity bias." See Pozdnyakov, Vladimir, and Steele, J. Michael. "Convexity Bias in Eurodollar Futures Prices: A Dimension-Free HJM Criterion." *Methodology and Computing in Applied Probability* 11, no. 4 (2009): 551-560; Gupta, Anurag, and Subrahmanyam, Marti G. "An empirical examination of the convexity bias in the pricing of interest rate swaps." *Journal of Financial Economics* 55.2 (2000): 239-279.

- c. DRW's bids on the Three Month Contract *are consistent with my calculations of the NPV effect and the convexity effect* using the Hull-White One-Factor model of expected interest rate dynamics applied on data from January through August 2011 (the "Relevant Period"). Based on this analysis, *DRW bid at reasonable prices which represented legitimate demand for the long side of the Three Month Contract and not "artificial prices,"* as alleged.
- d. Because DRW's bids on the Three Month Contract reflected the NPV and convexity effects, *they represent a clear example of legitimate price discovery in the Three Month Contract.*
- e. DRW's bids on the Three Month Contract offered premium rates relative to the non-cleared OTC interest rate swap with similar terms and therefore *were more representative of true supply or demand* for the Three Month Contract than were non-cleared prices on OTC interest rate swaps. In other words, prices of non-cleared OTC interest rate swaps did not reflect legitimate supply or demand for the Three Month Contract, but DRW's bids did.
- f. DRW's electronic bids on the Three Month Contract *represented true interest to buy at the posted prices and quantities throughout the trading day because: (a) they were posted for almost 47 minutes, on average, and thereby, exposed DRW to the risk of one of its posted bids being hit and (b) they were posted at rates within the range of (or consistently below) all estimates of fair value.*
- g. Contrary to the CFTC's assertion that DRW's bids active during the Three Month Contract's settlement period (1:45PM to 2:00PM CT, "Settlement Period"), were withdrawn "shortly thereafter," I find that *DRW's bids active during the Settlement Period were posted for more than 17 minutes, on average – longer than the 15-minute Settlement Period itself – and exposed DRW's trading interest broadly to the market.*
- h. DRW's profits did not depend on DRW's bids in the electronic market, as the CFTC alleges, but rather stemmed from interest rate movements and the fact that *DRW entered into a long position in the Three Month Contract at below fair value.* Whether or not DRW or another party posted bids at a premium after taking a position in the Three Month Contract (which more closely reflected supply or demand for the Three Month Contract), DRW would have realized substantially the same stream of cash flows generated by the exchange of variation margin over time.
- i. The shift from International Derivatives Clearinghouse ("IDCH")⁸ using OTC interest rate swap prices to more appropriate cleared Three Month Contract-specific prices was inevitable. *Given the real economic differences between an OTC*

⁸ IDCH is a wholly-owned subsidiary of the International Derivatives Clearing Group ("IDCG").

See Complaint ¶24.

interest rate swap and the Three Month Contract, a rate premium was appropriate for the Three Month Contract.

5. My detailed findings, opinions, and conclusions follow in this report and its appendices and exhibits. **Section III** provides a summary of my qualifications and the compensation I receive for my work on this matter. **Section IV** presents the types of documentation and materials I relied on in preparing this report. **Section V** provides background information on the current litigation. **Section VI** describes the characteristics and trading of OTC interest rate swaps and interest rate swap futures contracts. **Section VII** analyzes the Three Month Contract and how it differs from an OTC interest rate swap. **Section VIII** presents valuation analyses of the Three Month Contract and estimations of the NPV and convexity effects under the Hull-White One-Factor model. **Section IX** describes DRW's bids on the Three Month Contract. **Section X** explores price discovery as it relates to the current matter and explains that DRW's bids were important for price discovery. **Section XI** summarizes why there is no basis for claims of market manipulation or illicit profit. **Section XII** reviews and comments on the MacLaverty Report. Last, **Section XIII** concludes.

III. QUALIFICATIONS AND COMPENSATION

A. Summary of Qualifications

6. I, Jeffrey H. Harris, am the holder of both the Gary Cohn Goldman Sachs Chair in Finance and the Finance and Real Estate Department Chair at the American University in Washington, D.C. From 2011 to 2013, I served as the Dean's Chair in Finance at Syracuse University. Between 1995 and 2011, I was a professor, an assistant professor or a visiting assistant professor at The Ohio State University, the University of Notre Dame, Southern Methodist University, and the University of Delaware. During that period,

from 2006 to 2010, I also served as a consultant and as Chief Economist of the CFTC. Earlier, in 1999-2000, I was a visiting academic scholar at the U.S. Securities and Exchange Commission ("SEC") and, in 2000-2001, a visiting academic fellow at the NASDAQ Department of Economic Research.

7. My areas of research include finance, market microstructure, and regulatory issues. Over the course of my academic career, I have published scholarly articles in various journals including *Journal of Finance*, *Journal of Futures Markets*, *Journal of Financial Economics*, *Journal of Financial and Quantitative Analysis*, *Journal of Investment Management*, and *Review of Financial Studies*, among others. I have co-written chapters in finance books such as "Equity Market Derivatives" in *Financial Derivatives: Pricing and Risk Management* (2009).⁹ I have taught courses in options, futures, and other derivatives, empirical finance, and speculative markets at the undergraduate, master's, and doctoral levels.
8. I am currently serving as a director at the Eris Exchange. I have been a member of the Board of Directors for the Southern Finance Association and currently serve on the program committee for the European Finance Association and the Western Finance Association. I serve on the Editorial Advisory Board for the *Journal of Risk Finance* and actively referee papers for several finance and economics journals. I have also consulted with various organizations on finance-related issues and have provided testimony before the CFTC and U.S. Congress on numerous matters involving pricing and financial speculation.

⁹ Kolb, Robert W., and Overdahl, James A. *Financial Derivatives: Pricing and Risk Management*, Robert W. Kolb Series in Finance, John Wiley and Sons, Inc., 2009.

9. My *curriculum vitae*, which provides details of my qualifications, publications, and other professional activities, including a list of matters in which I have testified, is attached as **Appendix A**.

B. Compensation

10. I am being compensated for my time and services in this matter at the hourly rate of \$750. Certain employees of Analysis Group have provided support and assistance in preparing this report. My compensation is not contingent on the opinions that I express or the outcome of this litigation.

IV. DOCUMENTS AND MATERIALS CONSIDERED

11. In preparing this report, I have drawn on my education, knowledge, and experience in finance and derivatives developed over many years. I have also relied upon documents and other materials produced in this litigation as well as various industry publications and other publicly available material. Examples of the types of information I have considered in this report include the following:
- a. Legal pleadings and associated exhibits filed in connection with the current matter;
 - b. Plaintiff's legal submissions and the expert report of Mr. Robert M. MacLavery;
 - c. Various deposition transcripts and associated exhibits including those by Mr. Donald R. Wilson, Jr., Mr. Brian Vander Luitgaren, and Mr. Craig Silberberg;
 - d. Various documentary evidence related to the Three Month Contract produced in this matter; and

- e. Legal pleadings and associated exhibits filed in connection with the arbitration matter *Jefferies & Company, Inc. v. The NASDAQ OMX Group, Inc., International Derivatives Clearing Group, LLC, and International Derivatives Clearinghouse, LLC*.

12. A list of documents and materials considered in the preparation of this report is set forth in **Appendix B**. As my work on this matter is ongoing, I may review additional materials produced subsequent to the issuance of this report and/or conduct further analysis. Accordingly, I reserve the right to update, refine or revise my opinions, or form additional opinions. I also reserve the right to respond to any expert opinions put forward by the CFTC in response to the opinions presented in my report.

V. BACKGROUND OF THE LITIGATION

13. The CFTC alleges that defendants DRW and Donald R. Wilson, Jr. “manipulated and attempted to manipulate the daily settlement rates” of the Three Month Contract by illegally placing orders to move prices in their favor during the Relevant Period.¹⁰
14. As alleged in the Complaint, the Three Month Contract was cleared by IDCH and traded on the NASDAQ OMX Futures Exchange (“NFX”).¹¹ The Three Month Contract could be traded in two different ways: a) a voice broker could bring two parties together to enter a bilateral transaction and then submit the transaction to IDCH for clearing on the exchange (*i.e.*, an Exchange of Futures for Swaps transaction);¹² or b) parties could directly post executable electronic bids and offers on the exchange via a third party as allowed by IDCH and NFX. All of DRW’s long positions in 2010 were established

¹⁰ Complaint ¶1 and ¶5.

¹¹ Complaint ¶2.

¹² IDCG Marketing Presentation, pp. 6-7, D0163512-13.

through the first method via the voice broker NewEdge USA, LLC.¹³ Around August 2010, DRW had acquired a long position in the Three Month Contract for a notional principal of over \$350 million.¹⁴

15. The value of DRW's long position was marked to market every day (*i.e.*, gains and losses were accounted for at the end of each trading day) based on the daily settlement rates of the Three Month Contract for various maturities. Each day, IDCH determined these daily settlement rates, which collectively made the "IDEX Curve," using its proprietary methodology that incorporated, among other things, exchange activity on the NFX – including bids and offers made by market participants during the Settlement Period.¹⁵ In the absence of exchange activity, IDCH set its daily settlement rates to be the "prevailing interest rates in corresponding bilateral interest markets," which the Complaint defines as "Corresponding Rates."¹⁶
16. After DRW had acquired its long position, it came to recognize that IDCH did not settle the Three Month Contract at prices reflective of market activity in the voice broker market in which DRW had continued to participate.¹⁷ DRW informed IDCH accordingly and, at the suggestion of IDCH, began placing electronic bids shortly thereafter. DRW's electronic bids were made through a platform developed by Sky Road LLC, a company, which, I understand, was recommended to DRW by IDCH for that very purpose.¹⁸ DRW

¹³ Complaint ¶41.

¹⁴ Complaint ¶3.

¹⁵ Complaint ¶3.

¹⁶ Complaint ¶3.

¹⁷ See DRW Letter to IDCG, Investigation Number IDCH II 2011-1, February 18, 2011.

¹⁸ See Deposition of Donald R. Wilson, Jr., April 2, 2013, p. 18, p. 66, and p. 89; Email from IDCG to DRW, December 20, 2010, D0165286.

placed bids expressed in terms of a fixed interest rate, which, if accepted, were to be paid to the party with the short position on a semi-annual basis throughout the duration of the contract. The Complaint alleges that DRW placed bids primarily during the Settlement Period at interest rates higher than the Corresponding Rates that would otherwise prevail and withdrew these bids shortly afterwards to influence daily settlement rates in its favor.¹⁹ Over an 8-month period, DRW's bids allegedly caused IDCH to settle the Three Month Contract at rates increasingly higher than the Corresponding Rates. Using such mechanism, according to the CFTC, DRW allegedly improved the value of its open positions in the Three Month Contract. According to the CFTC, DRW's bids caused artificial prices on the Three Month Contract on at least 118 trading days affecting multiple maturities from seven to 30 years of over 1,000 contracts.²⁰

VI. OVERVIEW OF OTC INTEREST RATE SWAPS, INTEREST RATE SWAP FUTURES CONTRACTS, AND CENTRAL CLEARING

A. OTC Interest Rate Swaps

17. A swap is a derivative contract between two parties exchanging a series of cash flows at predetermined future dates. In an over-the-counter ("OTC" or off-exchange) interest rate swap, two parties reach an agreement to exchange periodic interest payments based on a

¹⁹ Complaint ¶5.

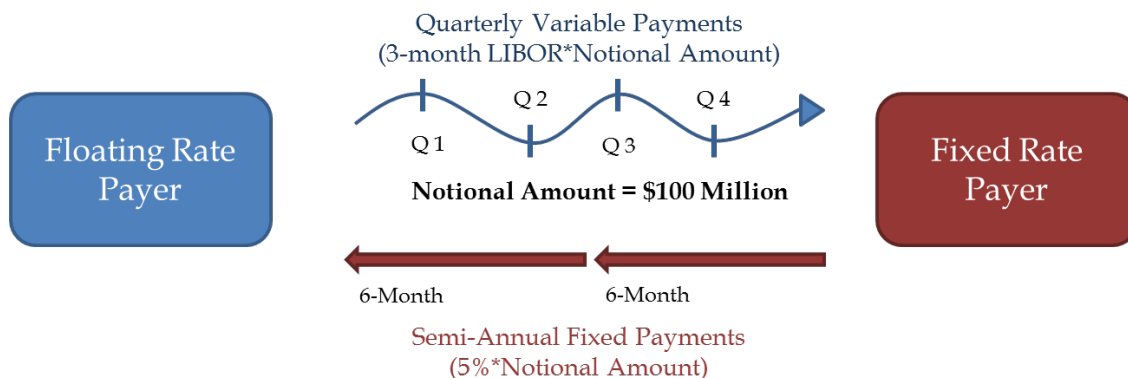
²⁰ Complaint ¶6 and ¶49.

predetermined notional amount.²¹ In simplified terms, each party pays a dollar amount calculated as the product of the agreed-upon interest rate and the notional amount.²²

18. In the simplest form of an OTC interest rate swap, one party known as the *fixed rate payer* makes fixed and periodic interest payments throughout the duration of the contract. The other party called the *floating rate payer* makes interest payments fluctuating in response to changes in a benchmark rate. Various money market rates can be used for determining the floating rate with the most common benchmark being the London Interbank Offered Rate (“LIBOR”).²³ As the most prevalent structure of a swap, a fixed-for-floating OTC interest rate swap is often called a “plain vanilla” interest rate swap.

Figure 1 below illustrates an example of an interest rate swap.

Figure 1: Illustration of an OTC Interest Rate Swap



19. In the above illustration, the fixed rate payer agrees to pay a 5% fixed rate of the notional amount of \$100 million on a semi-annual basis for a given contract maturity. In return,

²¹ Fabozzi, Frank J., and Mann, Steven V., *The Handbook of Fixed Income Securities*, Eighth Edition, McGraw Hill Professional, 2012, pp. 1445-46 (hereinafter “Fabozzi et al. (2012)”).

²² The notional amount represents the scale of the trade for the purpose of this calculation; it does not actually represent an amount transferred from one party to another.

²³ The LIBOR is the benchmark interest rate that major banks charge to lend funds to one another for a given maturity (e.g., 1-month LIBOR, 3-month LIBOR, or 6-month LIBOR).

the floating rate payer agrees to pay the 3-month LIBOR of the notional amount of \$100 million on a quarterly basis for the same contract maturity. As an interest rate derivative, the value of the interest rate swap changes relative to movements in interest rates, with the floating rate payer benefiting when interest rates (*i.e.*, LIBOR) decrease, and the fixed rate payer benefiting when interest rates increase.

B. Interest Rate Swap Futures Contracts

20. In a *futures contract*, a buyer (seller) agrees to receive (make) delivery of a valued item such as a commodity or financial securities at an agreed-upon price and date.²⁴ An interest rate swap futures contract is a futures contract based on the exchange of cash flows established by an underlying interest rate swap. The buyer of the futures contract is the fixed rate payer and is said to be *long the futures* and the seller of the futures contract is the floating rate payer and is said to be *short the futures*. As for an OTC interest rate swap, the value of the interest rate swap futures changes relative to movements in interest rates. For the fixed rate payer (floating rate receiver), the value of the interest rate swap futures increases when interest rates increase.²⁵ The floating rate payer (fixed rate receiver) benefits from declining interest rates.

C. Central Clearing of Interest Rate Swap Futures Contracts

21. While the payment terms, notional amount, and interest rates of the swap underlying the interest rate futures contract are identical to those of an OTC interest rate swap, the trading and cash flows of both instruments differ substantially.

²⁴ Fabozzi *et al.* (2012), p. 1370.

²⁵ Fabozzi *et al.* (2012), pp. 1464.

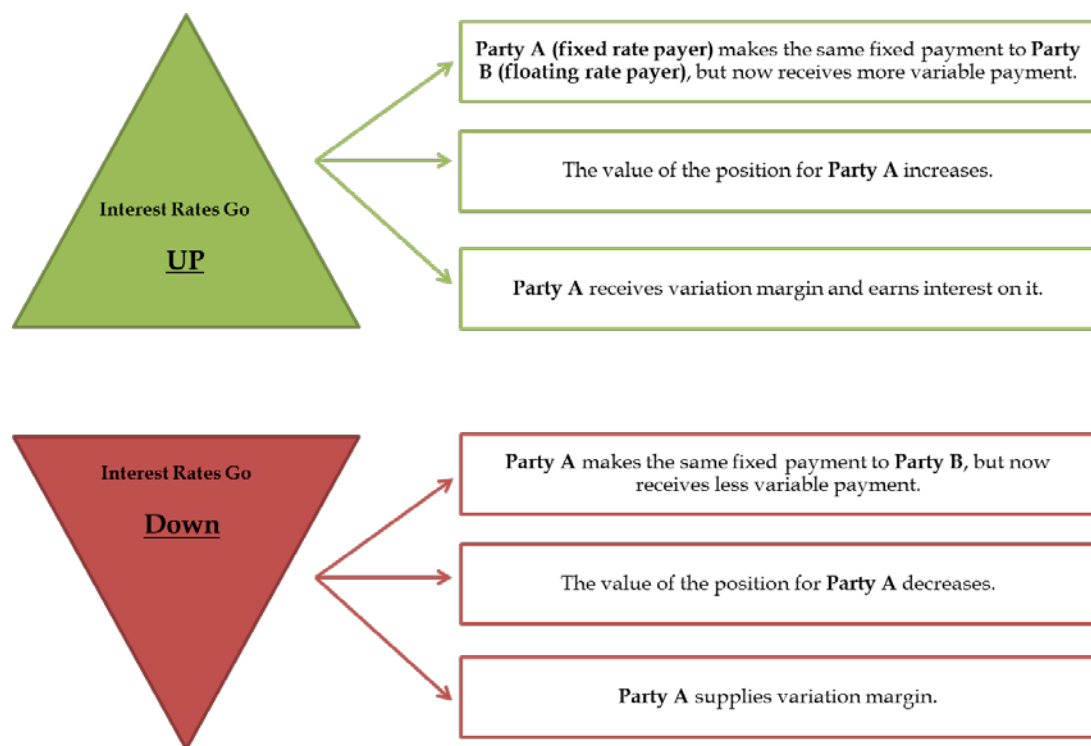
22. Like all futures contracts, interest rate swap futures contracts are cleared through a derivatives clearing organization, which acts as an intermediary between counterparties for the settlement or netting of transactions. In the current matter, the Three Month Contract was cleared through IDCH, a CFTC-registered clearing organization.²⁶ As the clearinghouse, IDCH was the central counterparty for all transactions involving the Three Month Contract, thus undertaking all counterparty default risk. That is, IDCH is the buyer to every seller and the seller to every buyer. If a party to a transaction defaults, then the loss would be borne by IDCH. To reduce its exposure to counterparty default risk, IDCH required a minimum deposit amount that an investor needed to make to take a position in the futures contract as required by the exchange. This minimum deposit amount is the *initial margin*.
23. As noted above, interest rate changes influence the daily settlement price of interest rate swap futures contracts. At the close of each trading day, positions in the futures contract are marked to market based on a daily settlement price determined by the exchange or clearinghouse. As such, any gain or loss in a given position is reflected daily in the settlement price of the position. Interest rate movements that reduce the settlement price (or the daily marked-to-market value) of a counterparty's open position require that counterparty to make an additional margin deposit (called the *variation margin*).²⁷ Conversely, interest rate movements that improve the daily marked-to-market value of a counterparty's open position result in that counterparty receiving variation margin. In other words, parties that hold open positions to the futures contract are subjected to cash

²⁶ IDCH was a subsidiary of the International Derivatives Clearing Group (IDCG).

²⁷ Fabozzi *et al.*, p. 1383.

payments (proceeds) of variation margin which they make to (receive from) the exchange depending on the value of their position based on settlement prices. **Figure 2** below illustrates the cash flows exchanged following a change in interest rates. After an increase in interest rates, Party A, the fixed rate payer, still makes the same fixed amount of payment but receives a higher variable amount. The marked-to-market value of the swap increases for Party A as interest rates increase and vice versa for Party B, the floating rate payer.

Figure 2: Illustration of Cash Flows Movements after a Change in Interest Rates



24. On a daily basis, for a cleared interest rate swap futures position (like the Three Month Contract), Party A receives variation margin when interest rates rise and earns interest on it, and is required to supply variation margin when interest rates fall. In contrast, with an OTC interest rate swap, Party A receives collateral when the value of its position increases but it does not keep the interest earned on such collateral.

VII. THE VALUE OF THE THREE MONTH CONTRACT DIFFERS FROM AN OTC INTEREST RATE SWAP DUE TO THE EXCHANGE OF VARIATION MARGINS BUT IDCH CHOSE NOT TO ACCOUNT FOR THIS WHEN IT DESIGNED THE THREE MONTH CONTRACT²⁸

25. **Exhibit 1** summarizes characteristics of the Three Month Contract some of which I discuss here. The Three Month Contract required the exchange of semi-annual fixed interest rate payments agreed upon by parties for floating interest rate payments based on the 3-month LIBOR. The underlying instrument was a U.S. dollar-denominated interest rate swap and the notional value was \$100,000.
26. Using its own methodology and procedures, IDCH determined a daily settlement price for each maturity. Importantly, IDCH expressly reserved for itself the sole discretion in establishing a daily settlement price that it has deemed a “fair and appropriate reflection of the market.”²⁹ Indeed, determining the proper settlement price is one of the most important functions of an exchange or clearinghouse, especially in relatively illiquid markets where pricing information is not plentiful. IDCH then constructed the “IDEX Curve” by connecting the individual daily settlement prices across the different maturities.
27. At the close of each trading day, IDCH estimated the value of each position in the Three Month Contract by calculating the net present value of cash flows based on discount factors generated from the IDEX Curve.³⁰ The estimated net present value of cash flows

²⁸ See Filtering, Prioritizing, and Modification of IDCG Data Feeds, IDCG00009826-28; Mr. O’Connor, former CEO of IDCG, testified that “[t]here were three main reasons why we did not include PAI in the futures environment. We thought it was unnecessary, we thought it was complex, and the clients that we were targeting were vocal that they did not want it in their clearing solution.” See Deposition of Garry O’Connor, February 29, 2012, pp. 21-22.

²⁹ IDCH Rulebook, p. 100.

³⁰ IDCH Rulebook, p. 100.

determined each party's daily profit or loss and the variation margin to be paid to or received from IDCH.³¹

28. As with most futures contracts, IDCH had clear methods for how its IDEX Curve was set. When there was exchange activity (*i.e.*, bids, offers, and/or executed trades), IDCH used a 3-tier method for incorporating such activity into its IDEX Curve calculation.³² In the absence of exchange activity, IDCH instead incorporated the Corresponding Rates into its IDEX Curve calculation.³³ Notwithstanding the foregoing, IDCH had final authority to act to achieve a price that was a "fair and appropriate reflection of the market."³⁴ IDCH made aspects of its curve calculation methodology available to market participants to give the confidence that margin accounts would be treated fairly and equitably based on these objective criteria.
29. As seen above, the Three Month Contract had the standard features of an interest rate swap combined with the daily cash flows associated with margins in an exchange-cleared futures contract. In this regard, the Three Month Contract was not equivalent to a non-cleared swap with similar terms. This fact cannot be disputed. I

³¹ IDCH Marketing Presentation, p. 9 and p. 14, D0163515 and D0163520.

³² See Filtering, Prioritizing, and Modification of IDCG Data Feeds, IDCG00009826-28 ("1. Where a bid and offer exist with a maximum configurable width the average of these two rates will be used; 2. Where a bid and offer exist with a width outside that described above but a trade was recently executed within that bid and offer spread, that traded rate will be used; 3. Failing either of the above the filtered and averaged raw data feed will be used [as a] constraint such that [it] can never be higher than the current best offer or lower than the current best bid in the order book.")

³³ See Deposition of Gerard Kopera, April 2, 2015, p. 22 ("Actual market transactions got the most weight, bids and offers got the second most weight, and observed OTC prices got the least weight"); Filtering, Prioritizing, and Modification of IDCG Data Feeds, IDCG00009826-28 ("[Prioritizing data feeds] involves combining price information from exchange based order book and observations from the Over the Counter (OTC) environment. As the observations of exchange activity represent verifiable transactions they are given priority over OTC observations").

³⁴ IDCH Rulebook, p. 100.

confirm below the differences in prices between these two instruments, validating the research by Cont *et al.* (2011) and Henrard (2012).³⁵

30. Other clearinghouses—such as LCH.Clearnet and the CME Group—incorporate an adjustment (known as Price Alignment Interest or “PAI”) to the daily amount of variation margin on certain of their cleared interest rate products to equilibrate the cleared instruments to their non-cleared counterparts. The PAI is the interest charged by the clearinghouse on cumulative variation margin received by a party (or paid by the clearinghouse on cumulative variation margin paid by a party) in an interest rate swap transaction.³⁶ Importantly, IDCH did not include a PAI or any similar adjustment in the construction specification of its Three Month Contract.
31. The value of a cleared Three Month Contract differs from the value of a non-cleared OTC interest rate swap for two reasons, both related to the exchange of variation margin for the cleared instrument, which I discuss in more detail below: the NPV³⁷ and the convexity effects.

³⁵ See Henrard, Marc, “Deliverable Interest Rate Swap Futures: Pricing in Gaussian HJM Model,” OpenGamma Quantitative Research n. 5 (2012), exploring price and hedging differences between OTC interest rate swaps and interest rate swap futures. Available at <http://www.opengamma.com/sites/default/files/deliverable-interest-rate-swap-futures-pricing-gaussian-hjm-model-opengamma.pdf>, (hereinafter “Henrard (2012)”).

³⁶ LCH.Clearnet defined its PAI adjustment as follows: “To minimize the impact of daily cash variation margin payments on the pricing of interest rate swaps, the Clearing House will charge interest on cumulative variation margin received and pay interest on cumulative variation margin paid in respect of these instruments. This interest element is known as *price alignment interest*.” See LCH Clearnet Update to Section 3.5.2 Price Alignment Interest (PAI) Rate, Published November 17, 2008, available at http://www.lchclearnet.com:8080/Images/section%203_tcm6-47191.pdf. Henrard (2012) describes how CME integrates an adjustment for the convexity effect into the price of its cleared interest rate swap futures.

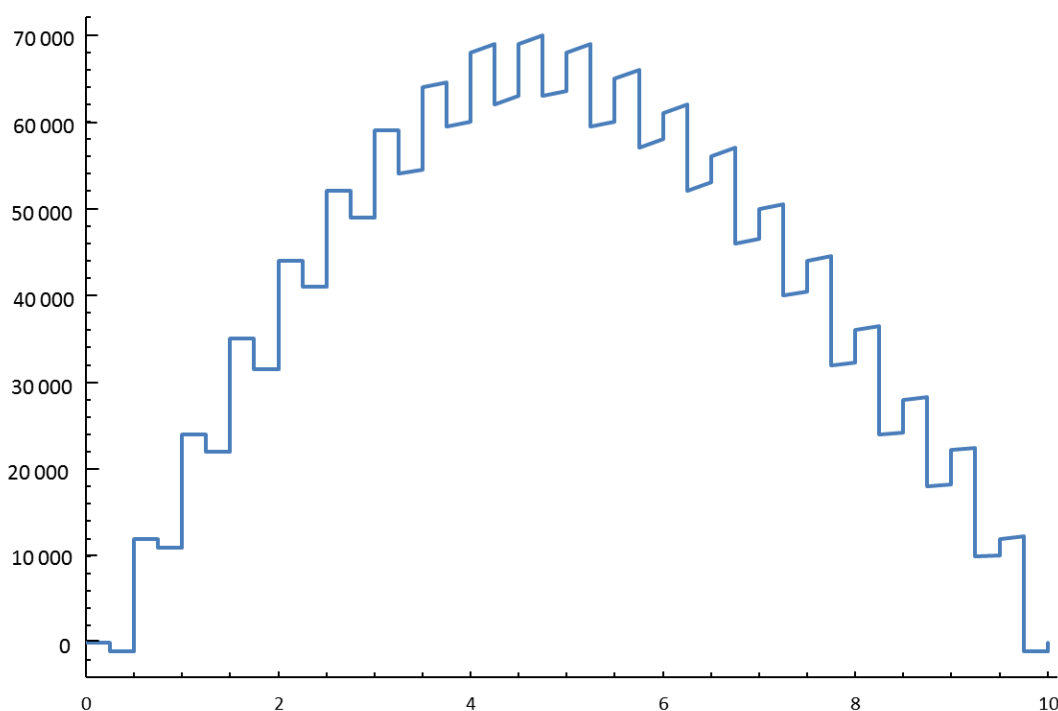
³⁷ Henrard (2012) refers to the NPV effect as “multiplication by a common factor ... This represents the fact that the profit is paid immediately (through the margin) and not a[t] settlement,” p. 45.

A. The Exchange of Variation Margins Generates a Net Present Value Effect

32. In an environment with an upward sloping yield curve (which is the environment that existed during the Relevant Period)—*i.e.*, rates increase over longer maturities—the remaining value of an interest rate swap increases to a positive value before it decreases to zero as it approaches expiry for the fixed rate payer (as shown in **Figure 3** below). While this is true for both an OTC interest rate swap and for the Three Month Contract, this daily change in value is actually paid to the fixed rate payer (through the payments of variation margin) only in the cleared Three Month Contract. This means that the net accumulated variation margin received by the fixed rate payer in the Three Month Contract is always positive and therefore the payer can generate a stream of positive cash flows by investing the variation received and keeping the interest. The fixed rate payer in an OTC interest rate swap doesn't receive the variation margin and as a consequence, does not receive the stream of positive cash flows. The net present value of this stream of positive cash flows is the NPV effect.
33. In other words, early in the life of the swap contract, the fixed payments exceed the floating payments because the agreed-upon fixed rate is higher than the short term variable benchmark rate. Therefore, during the time when the fixed rate is above the benchmark rate, negative cash flows accrue to the fixed rate payer and the NPV of the remaining payments is positive for the fixed rate payer. As the swap matures, the positive NPV of the remaining payments grows until the point in time where the variable rate payments exceed the fixed payments. From this point in time, the positive NPV converges toward zero at the end of the life of the swap. The fact that the fixed rate payer holds a positive NPV position, realized through the payments of variation margin, and earns interest on it during the life of the swap, is known as the NPV effect.

34. Below, **Figure 3** plots the NPV of the remaining payments for the fixed rate payer over the life of a hypothetical 10-year swap. The cumulative variation margins equal the NPV of the remaining payments at each point in time. The interest earned on these cumulative variation margins is the NPV effect.

Figure 3: Evolution of the Remaining NPV of Payments by the Fixed Rate Payer for a 10-Year Swap



B. The Exchange of Variation Margins Also Generates a Convexity Effect

35. Importantly, the NPV effect as illustrated above over the life of the contract is plotted assuming a static, upward-sloping yield curve (*i.e.*, a yield curve with higher rates at longer horizons and no volatility). In reality, interest rates change. The volatility of interest rates leads to a separate, but related, difference between OTC interest rate swap values and their cleared futures counterparts — the convexity effect.

36. As explained above, the value of an exchange-traded futures contract is marked to market on a daily basis, which includes a margining process, *i.e.*, a settlement at the end of each trading day. As a result of margining, the pattern of cash flows exchanged in a futures contract differs from that in an OTC interest rate swap, and sometimes by a substantial amount (particularly when markets are volatile). In interest rate markets, margining allows for the fixed rate payer (the buyer of the futures contract) to reinvest daily profits at a higher rate and losses to be financed at a lower rate, such that an interest rate futures contract is traded at a higher rate than a non-cleared OTC interest rate swap.
37. To illustrate this fact, consider an initial futures contract on a newly written OTC interest rate swap. If interest rates rise during the first part of the swap, the value of the futures contract will rise and the fixed rate payer (the buyer of the futures contract) will receive additional variation margin that can be invested at a higher rate. That is, the fixed rate payer collects more funds in the margin account and receives a higher interest rate on these funds (since rates have risen).
38. However, the opposite is not true, which leads to the convexity effect. Consider the opposite case where interest rates fall symmetrically during the first part of the swap causing futures rates to decrease. In this case, the fixed rate payer (the buyer of the futures contract) will post additional variation margin. However, while the margins are identical and opposite for the two cases, the interest earned on the variation margin received when interest rates rise is higher than the interest paid on the variation margin posted when interest rates decrease. That is, since margins are interest bearing accounts, the fixed rate payer (the buyer of the futures contract) makes more interest on the

additional margin than does the floating rate payer (the seller of the futures contract).³⁸

The average benefit (in present value terms) for the fixed rate payer (the buyer of the futures contract) represents the convexity effect.³⁹

39. Expected interest rate volatility is the subject of numerous financial models and, depending on the model of choice, the size of the estimated convexity effect can vary from trader to trader. Importantly, however, the convexity effect is real and makes the value of a swap futures position differ from that of an OTC interest rate swap. Although quantifying the NPV and convexity effects requires some modeling, both benefit the fixed rate payer in an interest rate swap futures contract. The fixed rate payer, therefore, would pay a higher fixed rate in a cleared futures contract than in an OTC interest rate swap with the same terms.
40. As mentioned above, many exchanges account directly for the NPV and convexity effects by assessing PAI, which is incorporated into the settlement process on the exchange. LCH.Clearnet SA, for instance, specifies that each "Clearing Member that receives Variation Margin payments from LCH.Clearnet SA is required to pay Price Alignment Interest."⁴⁰ When applied, the PAI is expressly stated "to minimise distortion of pricing for Original Transactions cleared through LCH.Clearnet SA as a result of daily

³⁸ Equivalently, the interest foregone on lower margin account funds is greater for the fixed rate payer (the buyer of the futures contract) when rates decrease.

³⁹ Complaint ¶21.

⁴⁰ See full set of PAI rules in LCH.Clearnet, CDSClear LCH.Clearnet SA, CDS Clearing Procedures, Section 2.14 - Margin and Price Alignment Interest, Published December 23, 2013. Available at: http://ftp.lch.co.uk/Images/cdsclear_section_2_procedures_combined_version_23_december_2013_tcm-6-64469.pdf. The CME Groups also charges PAI to the receiver of variation margin funds. Henrard (2012), p. 1.

Variation Margin payments and changes in the net present value of Open Positions.”⁴¹

These payments are calculated and applied on a daily basis by this exchange/clearinghouse.

41. Without PAI, LCH.Clearnet notes that the “transfer of Collateral in respect of variation margin, or change in NPV, on a daily basis *without adjustment would distort the pricing* for SwapClear Transactions cleared through the Clearing House.”⁴² (Emphasis added.) Given that the Three Month Contract lacked a PAI adjustment, the difference in value between the Three Month Contract and its non-cleared counterpart would be accounted for in another way, such as higher fixed rates that incorporate the value of the NPV and convexity effects. Indeed, only with the NPV and convexity effects reflected in daily settlement prices would IDCH contract prices reflect the Three Month Contract’s true economic value. In fact, DRW’s bids on the Three Month Contract rationally did this exact thing—DRW bid higher yields for the Three Month Contract, reflecting its willingness to pay a premium (relative to the Corresponding Rates) to the short futures side. These higher bids were closer to the true economic value of the Three Month Contract than the Corresponding Rates would have been.

⁴¹ LCH.Clearnet set its PAI rate at the effective federal funds rate for U.S. dollar denominated interest rate swaps. LCH.Clearnet, FCM Procedures of the Clearinghouse, LCH.Clearnet Limited, June 2015. Available at: <http://www.lchclearnet.com/documents/731485/762514/FCM+Procedures+-+23+06+15.pdf/fbf5ff8d-6b3e-4ea2-9cab-95d507b0c9a0>. Also LCH.Clearnet, CDSClear LCH.Clearnet SA, CDS Clearing Procedures, Section 2 – Margin and Price Alignment Interest, Published December 23, 2013. Available at: http://ftp.lch.co.uk/Images/cdsclear_section_2_procedures_combined_version_23_december_2013_tcm-6-64469.pdf.

⁴² LCH.Clearnet, LCH.Clearnet Limited Procedures Section 2C Swapclear Clearing Service, See Section 1.7.4, June 2014, p. 18. Available at <http://www.lchclearnet.com/documents/515114/632069/Procedures+section+2C+SwapClear+Service.pdf/8e86cd6d-5064-4184-8a7b-10e09a415e26>.

42. The convexity effect is also present in other markets that have structural cash flow differences between non-cleared and cleared markets. For instance, the Eurodollar futures market also reflects the convexity effect. **Exhibits 2A** and **2B** display the values of the implied par coupon from 7- and 10-year Eurodollar futures strips along with the corresponding non-cleared OTC interest rate swap rate. In both figures, we see that the value of the par coupon implied by the Eurodollar futures strip differs from the corresponding OTC interest rate swap rates due to the NPV and convexity effects, which averaged around 22 and 35 basis points, respectively, for the 7-year swap and 10-year swap over the Relevant Period. Similar to the NPV and convexity effects in the Three Month Contract, the historical Eurodollar convexity effect ranges between 10 and 40 basis points, and is larger for the longer-term contract.⁴³ Without adjustment to counteract the NPV and convexity effects (like, for example, PAI), the NPV and convexity effects benefit the party with the long position at the expense of the party with the short position.
43. In various depositions, DRW's employees have demonstrated their understanding of the NPV and convexity effects to explain why they bid at higher yields for the Three Month Contract.⁴⁴ According to their testimony, all of DRW's bids (both during and outside of the Settlement Period) reflected DRW's calculations of the NPV and convexity effects – they bid at higher yields, reflecting the fact that the short party could be expected to demand a higher yield to offset the NPV and convexity effects.

⁴³ Burghardt, Gerhard and William Hoskins (1994), "The Convexity Bias in Eurodollar Futures," Dean Witter Institutional Futures Research Note, p. 12.

⁴⁴ See Deposition of Donald R. Wilson, Jr., April 2, 2013, p. 56 and p. 103; Deposition of Craig Silberberg, December 03, 2014, pp. 89-90; Deposition of Brian Vander Luitgaren, November 19, 2014, pp. 66-67.

C. IDCH Recognized the Presence of the NPV and Convexity Effects in its Pricing

44. Garry O'Connor, former CEO of IDCG, has stated that he was aware of the fact that the lack of a PAI adjustment (or any other feature to compensate for the cash flows that would benefit the long party) led to a valuation difference between the Three-Month Contract and the corresponding OTC interest rate swap.⁴⁵

45. Also, by November 2010, IDCG recognized that there was a convexity effect in its pricing of a different cleared OTC contract that it was offering and decided to implement a PAI adjustment to those contracts.⁴⁶

D. The Corresponding Rates Are an Inaccurate Reference to Use to Settle the Three Month Contract Because, as a Result of the NPV and Convexity Effects, They Do Not Reflect Supply or Demand for the Three Month Contract

46. When the Corresponding Rates are used as a default price for the Three Month Contract, as IDCH did prior to the bids at issue in this matter, the settlement price will not reflect true supply or demand or fair value for the Three Month Contract. To the contrary, OTC prices will surely differ from prices of the Three Month Contract when the term structure of interest rates is not flat or when interest rates are not constant and not expected to remain constant (as is typically the case and was the case during the

⁴⁵ Deposition of Garry O'Connor, February 29, 2012, pp. 21-22.

Findings of Fact and Conclusions of Law in *Jefferies & Company, Inc. v. The NASDAQ OMX Group, Inc., International Derivatives Clearing Group, LLC, and International Derivatives Clearinghouse, LLC*, January 9, 2013, JEF-CFTC-476403-33, at Findings of Fact ¶28 and Conclusions of Law ¶22 (By October 15, 2010, "IDCG learned or had reason to know that ... Jefferies' September trades exposed Jefferies to substantially different risks from OTC IR Swaps of the same terms. Because of this knowledge, IDCG represented that it was endeavoring to include a PAI or PAI-like adjustment in the IR Swaps to which Jefferies was exposed...").

Email exchange between Michael Dundon and Rae Etherington regarding IDCH Adjustment of Revaluation Curve, January 24, 2011, JEF-CFTC-474513-514.

⁴⁶ IDCH Notice to Members No. 0003-10, Payment of Price Alignment Interest (PAI) into Variation Performance Bond for OTC Contracts Cleared by OTC Clearing Members, November 15, 2010, Exhibit 8 – JEF-CFTC-00000194-196.

Relevant Period). Moreover, any prices derived from the OTC market would be routinely and summarily considered by the market as inferior information sources relative to actual competitive bids in the Three Month Contract market—DRW’s bids in this case.⁴⁷

47. The fact that OTC rates (*i.e.*, the Corresponding Rates) can be (and were) used by IDCH as reference rates for the Three Month Contract given the lack of actual electronic bids does not mean that the Corresponding Rates were the most appropriate rates to apply. As noted above, the Three Month Contract and its non-cleared OTC interest rate swap counterpart have different economic values. Just as the process for valuing a home in Boston might be similar to the process for valuing a home in Detroit, it would not be appropriate to value Boston’s real estate based on Detroit prices. The supply or demand in the two markets would differ substantially (even if the houses looked similar and some participants might be common to both markets). Likewise, given the economic differences between the Three Month Contract and an OTC interest rate swap, the supply or demand in the two markets would also be expected to differ. When IDCH used OTC interest rate swap prices alone to settle the Three Month Contract, it settled the Three Month Contract on, at best, the supply and demand for something different—the value of the non-cleared swap. As explained below, when IDCH decided to use the bids posted electronically by DRW in 2011, IDCH began to settle the Three Month Contract based more closely on supply or demand for the Three Month Contract itself.

⁴⁷ See Filtering, Prioritizing, and Modification of IDCG Data Feeds, IDCG00009826-28 (“As observations of exchange activity represent verifiable transactions they are given priority over OTC observations.”)

VIII. VALUATION OF THE THREE MONTH CONTRACT AND ESTIMATION OF THE NPV AND CONVEXITY EFFECTS UNDER THE HULL-WHITE ONE FACTOR MODEL

48. In this section, I present my valuation of the Three Month Contract based on the Hull-White One-Factor model, which is an interest rate model that is commonly used in the industry and the same model used by Cont *et al.* (2011). I also discuss the methodology and findings presented by Cont *et al.* (2011).

A. Review of Valuation Framework

49. As discussed above in Section VII.D, the value of the Three Month Contract differs from the value of what appears to be an identical, non-cleared OTC interest rate swap. The difference in value arises from the daily cash flows associated with variation margin transfers under the Three Month Contract. Formally, the value of the Three Month Contract comprises two components: the value of an otherwise identical non-cleared OTC interest rate swap and the net present value of all daily variation margin transfers.

$$\begin{aligned} \text{Value of Three Month Contract} = & (\text{Value of Non-Cleared OTC Swap}) \\ & + \\ & (\text{Value of Movements in Variation Margin}) \end{aligned}$$

50. To value the Three Month Contract, one may value each of these two components separately. A value of a non-cleared OTC interest rate swap is determined by the swap's fixed rate; the schedule of fixed and floating payments; and the future term structure of interest rates, which indicates how the swap's floating payments are expected to evolve over time. The value of the swap is the net present value of cash flows based on these inputs.

51. The value of movements in variation margin depends on the term structure of interest rates and the volatility of interest rates during the life of the contract, as variation margin

flows when interest rates change. An interest rate model is used to estimate the volatility term structure and quantify how interest rates may evolve over time.

B. Valuation under the Hull-White One-Factor Model Applied to Swaptions

52. The Hull-White One-Factor model was first described by John C. Hull and Alan White in 1990.⁴⁸ Unlike many of its predecessor interest rate models, the Hull-White One-Factor model better fits real-world interest rates and interest rate volatilities, which is critical to pricing interest rate derivatives instruments correctly. To this day, the Hull-White One-Factor model remains a popular model for the evolution of future interest rates and is cited extensively in the academic literature, discussed in finance textbooks, and included in leading financial analysis software packages.⁴⁹

1. Assumptions and Data Inputs

53. The Hull-White One-Factor model assumes that today's term structure of interest rates represents the long-term average of future interest rates. Certain economic events, such as changes in the rate of economic growth, may cause future interest rates to differ from this central tendency. When this happens, the model assumes that future interest rates will gradually return to their long-term average over time.
54. The Hull-White One-Factor model takes certain inputs that influence the predictions of the model; these inputs are the Hull-White One-Factor model's "parameters."⁵⁰ There

⁴⁸ Hull, John, and White, Alan, "Pricing interest-rate derivative securities," *The Review of Financial Studies*, Vol. 3, No. 4 (1990) pp. 573-592.

⁴⁹ See Brigo, Damiano, and Mercurio, Fabio. *Interest rate models-theory and practice: with smile, inflation and credit*. Springer Science & Business Media, 2007, pp. 71-80; MATLAB Documentation, Financial Instruments Toolbox User's Guide, The Math Works, Inc., March 2015, Chapter 7, p. 6.

⁵⁰ The Hull-White one-factor model has two parameters. One of the parameters measures the volatility of short-term interest rates and the other parameter measures the speed with which interest rates return to their long-term average. This latter parameter is often referred to as the mean reversion speed parameter.

exist standard formulas based on the Hull-White One-Factor model that translate the model's parameters into prices of bonds, swaps, and other interest rate derivatives.

55. The specific values of the Hull-White One-Factor model parameters are commonly estimated, or "calibrated," to financial market data. Calibration consists of choosing parameter values such that the Hull-White One-Factor model (i) fits the current term structure of interest rates and (ii) predicts prices of interest rate derivatives that are consistent with the prices observed in the market.

2. Pricing and Calibration

56. In my analysis of the value of the Three Month Contract, I calibrate the Hull-White One-Factor model to publicly available data on short- and long-term interest rates and prices of interest rate swaptions.⁵¹ I recalibrate the Hull-White One-Factor model on a daily basis during the Relevant Period. This ensures that my valuation of the Three Month Contract reflects then-current market conditions accurately.
57. I use the calibrated Hull-White One-Factor model to value the Three Month Contract under the valuation framework described above on each day during the Relevant Period. I define the fair coupon of the Three Month Contract as the fixed rate such that the value of the fixed cash flows equals the value of the floating cash flows. Further, I estimate the NPV and convexity effects for the Three Month Contract as the difference of the fair coupon rates and the Corresponding Rates. The sum of the NPV and convexity

⁵¹ An interest rate swaption is a contract that grants the holder the right, but not the obligation, to enter into a certain interest rate swap at a certain time in the future. Hull (2011), p. 659. Swaption prices are commonly quoted for a wide range of option exercise terms and underlying swap maturities, each of which may range from one month to thirty years. I obtained the market data used in my analysis from Bloomberg, L.P.

effects reflects the amount by which the fixed payer benefits from variation margin under the Three Month Contract, relative to a non-cleared OTC interest rate swap.

3. Summary of Findings

58. **Exhibits 3A to 3G** demonstrate my estimates of the NPV and convexity effects for the Hull-White One-Factor model calibrated to swaptions compared to the difference between DRW's bids and Corresponding Rates during the Relevant Period for several maturities of the Three Month Contract.⁵² I find that my valuation of the Three Month Contract and daily estimates of the NPV and convexity effects are consistently in the range of DRW's bids during the Relevant Period across multiple maturities.
59. **Exhibits 4A to 4G** demonstrate the same estimates of the NPV and convexity effects for the Hull-White One-Factor model calibrated to swaptions compared to the difference between the IDEX Curve and Corresponding Rates during the Relevant Period for several maturities of the Three Month Contract.⁵³ I find that my valuation of the Three Month Contract and daily estimates of the NPV and convexity effects are consistently in the range of the IDEX Curve during the Relevant Period across multiple maturities.

C. Valuation under the Hull-White Model Applied to Eurodollar Futures

60. As discussed above, the NPV and convexity effects are also present in other markets. As an alternative valuation approach, I use the NPV and convexity effects observed in the Eurodollar futures market to generate estimates for the parameters of the Hull-White One-Factor model.

⁵² Exhibits 3A to 3G also demonstrate my estimates of the NPV and convexity effects for the Hull-White One-Factor model calibrated to Eurodollar Futures compared to the difference between DRW's bids and Corresponding Rates, as described in Section VIII.C.

⁵³ Exhibits 4A to 4G also demonstrate my estimates of the NPV and convexity effects for the Hull-White One-Factor model calibrated to Eurodollar Futures compared to the difference between the IDEX Curve and the Corresponding Rates, as described in Section VIII.C.

61. The Hull-White One-Factor model provides a standard formula with which to calculate the size of this NPV and convexity effects that are embedded in the prices of Eurodollar futures contracts.⁵⁴ I employ this formula to estimate Hull-White One-Factor model parameters that are consistent with the implied par coupons, Corresponding Rates, and NPV and convexity effects shown in **Exhibits 2A** and **2B**.

1. Pricing and Calibration

62. Under this approach, I calibrate the Hull-White One-Factor model to publicly available data on prices of Eurodollar futures contracts. I recalibrate the Hull-White One-Factor model on a monthly basis to ensure that my valuation of the Three Month Contract reflects then-current market conditions.

2. Summary of Findings

63. **Exhibits 3A** to **3G** also demonstrate my estimates of the NPV and convexity effects for the Hull-White One-Factor model calibrated to Eurodollar futures compared to the difference between DRW's bids and Corresponding Rates during the Relevant Period for several maturities of the Three Month Contract. Similar to the Hull-White One-Factor model calibrated to swaptions above, I find that my valuation of the Three Month Contract and estimates of the NPV and convexity effects are consistently in the range of DRW's bids during the Relevant Period across multiple maturities.

⁵⁴ See Hull, John C., *Options, futures and Other Derivatives, Eighth Edition*, Prentice Hall, 2011, p. 140 and Technical Note No. 1, "Convexity Adjustments to Eurodollar Futures," Available at: <http://www-2.rotman.utoronto.ca/~hull/technicalnotes/TechnicalNote1.pdf>.

The MATLAB software provides a function, `liborfloat2fixed`, that calculates the implied par fixed rate on a swap given prices of Eurodollar futures contracts. This function includes an option to calculate an adjustment for the NPV and convexity effects. This adjustment uses the Hull-White model adjustment formula discussed above. Using this MATLAB function, I choose Hull-White model parameter values such that the adjusted par fixed rates match the actual 7-year and 10-year Corresponding Rates during the Relevant Period as closely as possible.

64. **Exhibits 4A to 4G** also demonstrate the same estimates of the NPV and convexity effects for the Hull-White One-Factor model calibrated to Eurodollar futures compared to the difference between the IDEX Curve and Corresponding Rates during the Relevant Period for several maturities of the Three Month Contract. I find that my valuation of the Three Month Contract and daily estimates of the NPV and convexity effects are consistently in the range of the IDEX Curve during the Relevant Period across multiple maturities.

D. Results from Valuation Analyses Corroborate the Results and Methodology of Cont *et al.* (2011)

65. I find that the methodology presented in Cont *et al.* (2011) is consistent with the valuation framework I have described above, which is based on an analytical model that is widely used and accepted in the field of financial valuation. However, the precise results of my valuation analyses are not identical to those of Cont *et al.* (2011). This is not at all surprising or concerning. Interest rate modeling involves the choice of modeling assumptions and data inputs. Differing specific assumptions and inputs naturally translate into differing valuations, as confirmed by the various analyses that I performed.

IX. DRW'S BIDS ON THE THREE MONTH CONTRACT WERE PLACED AT HIGHER RATES THAN THOSE ON A NON-CLEARED SWAP REFLECTING THE VALUE OF THE NPV AND CONVEXITY EFFECTS

66. In this section, I review DRW's bids made on the Three Month Contract. I explain that DRW was ready to, and indeed would likely want to, consummate any potential transaction on these bids on the Three Month Contract because:

- a. DRW's bids were placed throughout the trading day and remained posted long enough to potentially attract a counterparty to trade during the Settlement Period;⁵⁵
- b. DRW's bids carried higher rates than those on a non-cleared OTC interest rate swap, thereby accounting for the presence of the NPV and convexity effects to reflect a value closer to fair market value, which would be more likely to attract a counterparty.

A. DRW's Bids Were Placed throughout the Trading Day and Remained Opened for Trading

- 67. **Exhibit 5** provides a summary of DRW's bids on the Three Month Contract. Based on the data that I have reviewed, DRW placed a total of 2,895 bids of which 1,165, i.e., 40% of bids, were placed during the fifteen-minute Settlement Period.
- 68. On average, the unmatched bids placed during the Settlement Period remained open for more than 17 minutes prior to deletion as shown in **Exhibit 6**. This time period is sufficiently long for potential investors to accept DRW's bids. In fact, the average 17 minutes between bid placement and deletion is an extremely long window of time, reiterating the fact that DRW was ready to trade at posted prices and provided ample opportunity for other investors to trade at these prices as well.

B. DRW Accounted for the NPV and Convexity Effects by Placing Bids at Rates Higher than the Corresponding Rates and Closer to All Legitimate Estimates of the Fair Value of the Three Month Contract

- 69. To adjust for the NPV and convexity effects on the Three Month Contract, DRW placed bids at rates higher than Corresponding Rates. **Exhibits 7A to 7G** show graphs of

⁵⁵ The PM Settlement Period is between 1:45PM – 2:00PM Central Time. Complaint ¶28.

DRW's bids and the Corresponding Rates over the Relevant Period. **Exhibits 8A to 8G** show graphs of the Corresponding Rates and IDEX Curve rates over the Relevant Period. For maturities of 7-, 10-, 12-, 15-, 20-, 25-, and 30-years, DRW's bids remained consistently higher than Corresponding Rates during the Relevant Period.

70. DRW's bids represented firm commitments to trade at the posted prices for notional values up to the posted quantities. As such, if DRW's bids had been hit by other traders in the market, DRW would have been committed to trade at these publicly-posted prices. IDCH affords no reneging on bids that are hit by other customers. Moreover, DRW's bids were competitive, in that they were posted at higher prices—and closer to all legitimate estimates of fair market values—than the Corresponding Rates. DRW's bids represent a proper use of the electronic exchange—to advertise a firm willingness to trade at better, more competitive prices to other traders.

X. WHETHER OR NOT A COUNTERPARTY HIT THEM, DRW'S BIDS WERE INVALUABLE FOR, AND A LEGITIMATE SOURCE OF PRICE DISCOVERY

71. In this section, I discuss the importance of price discovery in the context of the current matter. More specifically, I explain (i) what price discovery is in financial markets; (ii) the means by which price discovery is conducted by exchanges and clearinghouses; (iii) the nature of price discovery in illiquid markets; (iv) why regulators and market participants (*i.e.*, investors, exchanges, and clearinghouses) are strongly incentivized to participate in price discovery; and finally (v) the effects of price discovery on the settlement of futures contracts.

A. DRW's Bids Contributed to Price Discovery Because They Incorporated Relevant Information into the Market

72. In simple terms, price discovery, one of the central tenets of financial markets, is the process of determining the price of an asset, a good or a service. Finding the proper price involves analysis of demand or supply factors as well as other factors related to the transaction, the market, and available information.⁵⁶
73. At its core, price discovery “involves the incorporation of new information into asset prices.”⁵⁷ As O’Hara (2003) notes, “[t]raders with superior information will move prices toward full information levels ... new information arrives, old information becomes stale, and even informed traders may face risks that their information is obsolete.”⁵⁸ DRW’s bids, at a premium rate that represented the NPV and convexity effects, certainly reflected new information in the marketplace relevant to the Three Month Contract price given that DRW had extensively studied the Three Month Contract⁵⁹ and its proper valuation, and modeled and incorporated the NPV and convexity effects into its bids.
74. The CFTC and its expert Mr. MacLavery incorrectly conclude that an artificial price existed because IDCH established its IDEX Curve based on the Corresponding Rates before the Relevant Period, whereas during the Relevant Period it established its IDEX

⁵⁶ Lehmann, Bruce N. “Some desiderata for the measurement of price discovery across markets.” *Journal of Financial Markets* 5.3 (2002): 259-276 (hereinafter “Lehmann (2002)”). Lehmann (2002) similarly describes price discovery as “the efficient and timely incorporation of the information implicit in investor trading into market places.”

⁵⁷ O’Hara, Maureen. “Presidential Address: Liquidity and Price Discovery,” *Journal of Finance* 58.4 (2003): 1335-1354, p. 1339 (hereinafter “O’Hara (2003)”).

⁵⁸ O’Hara (2003), p. 1351.

⁵⁹ Email exchange between Gerard Kopera and Garry O’Connor regarding “IDCG Curve Question from DRW,” June 18, 2010, IDCG00002661-2 (“It seems that DRW is trying to understand our curve construction methodology with a degree of precision that we have not seen from other clients.”)

Curve at rates that reflected DRW's bids.⁶⁰ Rather, a shift in pricing regimes across time is completely consistent with price discovery. A more appropriate view of the regime change in the IDEX Curve is that DRW brought new, valid information to the market, which IDCH incorporated to establish a new equilibrium curve.

75. DRW's contribution to price discovery is significant for several reasons. First, price discovery reduces uncertainty by providing market participants with a "fair and appropriate" price based on bids or offers on which market participants are genuinely willing to transact.⁶¹ Reducing uncertainty decreases transaction costs, which in turn encourages trading and increases liquidity. Given the fact that no transactions for the Three Month Contract were consummated during the Relevant Period, DRW's bids were the primary source of price discovery in the Three Month Contract market. Second, the dissemination of information collected through price discovery also contributes to building investor confidence and maintaining stable financial systems.⁶² As correspondence between DRW and IDCH indicate, IDCH directly encouraged DRW's bids during the Settlement Period.⁶³

⁶⁰ Complaint ¶¶3 and ¶34.

⁶¹ IDCH Rulebook, p. 100.

⁶² OECD, "New Approaches to Economic Challenges," April 2015. Available at: http://www.oecd.org/naec/NAEC_Projects-Overview_Reflection-and-Horizon-Scanning.pdf.

⁶³ "On December 15, 2010, IDCH informed DRW that it would not be necessary to change the settlement process if DRW could inject its quotes into IDEX's electronic system and by doing so such quotes would be reflected in the settlement prices. IDCH subsequently provided a list of third party vendors that could be utilized for injecting quotes. DRW entered into a licensing agreement with Sky Road, one such vendor and on January 24, 2011 began entering orders into IDEX's electronic system through the Sky Road system." DRW Letter to IDCG, Investigation Number IDCH II 2011-1, February 18, 2011.

Deposition of Gerard Kopera, April 2, 2015, pp. 73-74:

"Q. Do you recall any internal conversations at IDCH about DRW's intention to stream bids electronically? A. Yes.

B. Regulators Should and Do Promote Price Discovery

76. Financial regulators around the world, and particularly in the U.S., view price discovery as one of the most fundamental functions of financial markets. The SEC, the CFTC, and other regulators encourage and facilitate price discovery on financial markets through myriad rules and regulations predicated on improving price discovery. Moreover, the CFTC, in particular, relies on price discovery metrics to exert regulatory authority in relatively illiquid markets.⁶⁴
77. The CFTC's commitment to price discovery is not new and has long served as an underpinning economic principle in the markets it regulates. The 1997 CFTC Annual Report notes: "Through effective oversight regulation, the CFTC enables the commodity futures markets better to serve their important functions in the nation's economy – providing a mechanism for price discovery and a means of offsetting price risk."⁶⁵
78. The CFTC, throughout its rulemaking and policymaking processes, has emphasized its commitment to price discovery as a positive aspect of financial markets. In 1998, shortly before the Commodity Futures Modernization Act of 2000, the CFTC put price discovery front and center in its Statement of Regulatory Priorities: "The Commission's objectives are to: (1) Foster futures and option markets that accurately reflect the forces of supply or demand for the underlying commodity and are free of disruptive activity; (2) oversee

Q. And what do you recall -- **A.** We were advocating for a while that we wanted customers to do that, so when clearing participants indicated that they were interested in actually participating in our marketplace, we were happy about that."

⁶⁴ See, for instance, CFTC (2009), "Significant Price Discovery Contracts on Exempt Commercial Markets; Final Rule" at <http://www.cftc.gov/ucm/groups/public/@lrfederalregister/documents/file/e9-6044a.pdf>

⁶⁵ CFTC 1997 Annual Report.

markets which can be used effectively by producers, processors, financial institutions, and other firms for the purposes of price discovery and risk shifting[.]”⁶⁶

79. The CFTC also encourages robust mechanisms for price discovery, particularly for exchange procedures during settlement periods. The CFTC, through Core Principle L, dictates that a Designated Clearing Organization (“DCO”) makes information about rules and operating procedures governing its clearing and settlement systems available to all market participants. The CFTC recognizes the importance of the settlement period for derivatives products, requiring regulated exchanges to publish and enforce rules that govern the settlement period, including the determination of settlement prices. The CFTC’s Division of Swap Dealer and Intermediary Oversight (DSIO, formerly the Division of Clearing and Intermediary Oversight, or DCIO) evaluates the clearing and settlement procedures of all contracts. Included in this evaluation is a consideration of whether settlement prices and procedures are robust to potential manipulation or distortions. The settlement procedures for the Three Month Contract were vetted properly by the CFTC in this case.⁶⁷
80. Core Principle L also requires a DCO to provide: (a) The terms and conditions of each contract, agreement, and transaction cleared and settled by the DCO; (b) the fees that the DCO charges its members and participants; (c) the DCO’s margin-setting methodology, and the size and composition of its financial resources package; (d) daily settlement

⁶⁶ CFTC, Statement of Regulatory Priorities, 63 FR 61402-01, November 9, 1998.

⁶⁷ See Deposition of Gerard Kopera, April 2, 2015, ¶¶19-20; Deposition of Michael K. Dundon, April 1, 2015, ¶¶114:10-12; Deposition of Robert Wasserman, April 22, 2015, ¶¶35-36.

prices, volume, and open interest for each contract the DCO settles or clears; and (e) any other relevant matter to clearing participants.⁶⁸

81. As Chief Economist of the CFTC in 2008, I gave testimony to the U.S. House of Representatives Subcommittee on General Farm Commodities and Risk Management Committee on Agriculture regarding the importance of price discovery and the problems inherent in markets where price discovery is impeded. In a joint statement with John Fenton (then Director of Market Surveillance at the CFTC), I noted “Diminished hedging activity can also impair price discovery in futures markets since commercial hedgers typically are a primary source for new market information. Diminishing the ability of futures markets to serve their hedging and price discovery functions would likely have negative consequences for commerce in commodities and ultimately, for the nation’s economy.”⁶⁹ This same testimony included insight into the resources devoted to monitoring and improving price discovery in U.S. markets, noting “At the Commission, we are devoting, and will continue to devote, an extraordinary amount of resources to ensure that futures markets are responding to fundamentals and are serving the role of hedging and price discovery.”⁷⁰
82. Following the 2010 Dodd-Frank Wall Street Reform and Consumer Protection Act, the CFTC reiterated the importance of price discovery in markets that the CFTC regulates.

⁶⁸ CFTC, Derivatives Clearing Organization General Provisions and Core Principles, Federal Register/Vol. 76, no. 216, CFTC 17 C.F.R Parts 1, 21, 39, and 140, RIN 3038-AC98, November 8, 2011.

⁶⁹ CFTC, Written Testimony of Jeffrey Harris, Chief Economist, and John Fenton, Director of Market Surveillance Before the Subcommittee on General Farm Commodities and Risk management, Committee on Agriculture, United States House of Representatives, May 15, 2008, p. 4.

⁷⁰ CFTC, Written Testimony of Jeffrey Harris, Chief Economist, and John Fenton, Director of Market Surveillance Before the Subcommittee on General Farm Commodities and Risk management, Committee on Agriculture, United States House of Representatives, May 15, 2008, p. 18.

The CFTC's Proposed Rules address "the specific requirements associated with protecting the price discovery function of trading on a DCM's centralized market as now specifically imposed by the Dodd-Frank Act."⁷¹

83. Similarly, price discovery serves to underpin the CFTC's Core Principles, which govern prospective regulation. Rules promulgated by the CFTC must be assessed under a cost-benefit analysis that lists price discovery as paramount to market and public concern. Section 15(a) of the Commodity Exchange Act requires the Commission to "consider the costs and benefits" of its actions within "five broad areas of market and public concern: (1) Protection of market participants and the public; (2) efficiency, competitiveness, and financial integrity of futures markets; (3) price discovery; (4) sound risk management practices; and (5) other public interest considerations."⁷²
84. Futures markets that operate under the regulatory oversight of the CFTC as designated contract markets ("DCM," *i.e.*, board of trades or exchanges) are subject to certain rules and principles, one of which is to protect and facilitate price discovery. The CFTC's Core Principles state: "The board of trade shall provide a competitive, open, and efficient market and mechanism for executing transactions that protects the price discovery process of trading in the centralized market of the board of trade."⁷³ A CFTC representative has also reiterated a commitment to price discovery in this case, noting "The Division of Market Oversight I mean is a fairly descriptive term. That is to say they are looking at markets. They are trying to ensure that the markets serve their purposes

⁷¹ CFTC, Core Principles and Other Requirements for Designated Contract Markets, 75 FR 80572-01 Proposed Rules, CFTC 17 CFR Parts 1, 16, and 38, RIN 3038-AD09, December 22, 2010.

⁷² CFTC, Core Principles and Other Requirements for Designated Contract Markets, 77 FR 36612-01 Rules and Regulations, CFTC 17 CFR Parts 1, 16, and 38, RIN 3038-AD09, June 19, 2012.

⁷³ CFTC, Code of Federal Regulations, §38.500 Core Principle 9, 17 C.F.R. §38.500, August 20, 2012.

of price discovery. There are no corners and such, so, essentially, they'd be looking at this from a market, a market integrity perspective."⁷⁴

85. As such, price discovery is an important function of futures markets and a primary area of regulatory oversight for the CFTC. In my opinion, the CFTC's allegations in the current matter serve to dissuade market participants from contributing to price discovery because the CFTC is seeking to punish legitimate price discovery in a market where little price discovery existed prior to DRW's bidding activity.

C. Clearinghouses Also Promote Price Discovery and Recognize it as a Legitimate Economic Reason to Post Bids or Offers

86. Beyond regulatory requirements, clearinghouses have strong financial incentives to ensure that a market has a rigorous price discovery mechanism. As the counterparty to all traders, a clearinghouse needs to ensure that market participants are able to comply with all clearing and settlement rules, including those related to margining. While a clearinghouse is technically never long nor short a derivatives security, the clearinghouse suffers the loss if a participant defaults on a contract. Thus, the clearinghouse can diversify the risk of any one participant defaulting by attracting a greater number of clearing participants. Moreover, if settlement prices do not reflect true supply or demand, the margins collected by the clearinghouse may not adequately cover the risk of clearing member default. In this light, an effective price discovery market is also financially important and beneficial to the clearinghouse, as price discovery aids in ensuring that settlement prices reflect true supply and demand.

⁷⁴ See Deposition of Robert Wasserman on Behalf of the CFTC, April 22, 2015, 40:1-7.

87. For instance, in a regulatory bulletin, Eurex US, a former derivatives exchange that owned a clearinghouse, stated that investors must ensure that market participants trade for one of three legitimate economic purposes, expressly including price discovery:

“The Exchange would like to remind Members of the responsibility to ensure that bids and offers are entered on the Trading System for legitimate economic purposes. Eurex US Rule 308(p) provides that Members shall not ‘Engage in conduct or practices inconsistent with just and equitable principles of trade or conduct or practices detrimental to the best interests of the Exchange.’ Legitimate economic activity includes hedging, speculation, and price discovery.”⁷⁵

88. Similarly, the CME Group, an options and futures exchange, considers price discovery (along with risk management) as one of its two most important functions.⁷⁶ For price discovery, the CME Group uses daily settlement prices, which it defines as the “fair market value of a commodity or financial derivative as determined by buyers and sellers in a market at a particular point in time known as the settlement period.”⁷⁷ Hasbrouck (2002) notes that “true” (or efficient) prices are generally unobservable, so that empirical studies often focus on price changes to efficient prices to measure price discovery.⁷⁸ In the absence of directly observable “true” prices, settlement procedures typically weigh actual transactions more heavily than bid and ask quotes. Likewise, in somewhat of a

⁷⁵ Eurex US regulatory Bulletin, “Legitimate Economic Purpose Required for Trading at Eurex US; Intrafirm Trading,” Rule 308 #5-008, Date Issued: April 13, 2005, Effective Date: April 14, 2005, Exhibit Rose-17.

⁷⁶ CME Group, “Quick Facts on Settlements at CME Group,” October 2014, Available at: <https://www.cmegroup.com/trading/agricultural/files/settlementprice-fact-sheet.pdf>. See also DRWI001942 – DRWI001943 (email from CME Group to DRW stating: “If you are available/interested in submitting options price contributions today we would very much appreciate your input. We will send you futures settlements as soon as we receive them in order to speed up the option settlement process. If we don’t receive contributions, we are planning to use the volatility skews from Monday Nov 10th and apply today’s futures settlements and update puts and calls with the new futures settlement price.”)

⁷⁷ CME Group, “Quick Facts on Settlements at CME Group,” October 2014, Available at: <https://www.cmegroup.com/trading/agricultural/files/settlement-price-fact-sheet.pdf>.

⁷⁸ See Hasbrouck, Joel. “Stalking the “Efficient Price” in Market Microstructure Specifications: An Overview,” *Journal of Financial Markets* 5 (2002): 329-339.

pecking order, bid and ask quotes are typically weighed more heavily than are prices from other markets.⁷⁹

89. Because the clearinghouse takes on the full counterparty credit risk in futures markets, in the event that a party to a transaction defaults, the clearinghouse must be able to find a replacement party to the transaction in order to avoid losses. If settlement prices do not reflect fair market value, this would not be possible. Defaults to the clearinghouse can be extremely costly. When MF Global went bankrupt in October 2011, for instance, the CME Group (MF Global's primary U.S. clearinghouse) was forced not only to cover the defaulted funds, but also to establish a separate \$100 million fund to protect other customers (including family farmers and ranchers).⁸⁰ The MF Global default also imposed reputational costs and other management costs on the CME to the point where the exchange started a specific web page dedicated solely to MF Global news, including five "Clearing Advisories" and references to "restoring confidence."⁸¹
90. Therefore, in futures markets, settlement periods (governed by specific rules) are dedicated to collecting the most diverse set of potential buyers and sellers to establish

⁷⁹ For instance, CME settlement procedures for interest rate swap futures use a 2-tier approach that prioritize trades during specific periods over bid and asks and other market information. Available at: <http://www.cmegroup.com/confluence/display/EPICSANDBOX/Interest+Rate+Swaps>.

Similarly, CME Gold and FX Futures settlement procedures are very specific, for instance, ranking trades as Tier -1, quote midpoints as Tier-2 and one-sided quotes as Tier-3 settlement price determinants to be weighed before considering "other market information." Available at: <http://www.cmegroup.com/confluence/display/EPICSANDBOX/Gold> and <http://www.cmegroup.com/confluence/display/EPICSANDBOX/Mexican+Peso>.

⁸⁰ See CME Group Press Release, "CME Group Establishes \$100M Fund to Provide Additional Protection for Family Farmers and Ranchers", February 2, 2012. Available at: <http://investor.cmegroup.com/investor-relations/releasedetail.cfm?ReleaseID=645279>.

⁸¹ See CME Group Website, "CME Group Information Regarding MF Global." Available at: <http://www.cmegroup.com/clearing/mfglobal.html>.

robust prices for clearing and settlement purposes. Markets assess settlement prices over an appropriate length of time, and typically include (in descending order of importance) some combination of transaction prices, bid and ask quotes, and volume from both floor-based and electronic markets (where applicable). In the absence of specific pricing data on an individual futures contract, settlement committees (comprised of exchange staff) often benchmark settlement prices to other contracts, earlier data, or other available market information to determine an appropriate settlement price.⁸² On occasion, settlement procedures may specify spread criteria when benchmarking to these other pricing sources. Importantly, the exchange and/or the clearinghouse control these rules and are solely responsible for producing daily settlement prices.⁸³

91. In sum, exchanges (and clearinghouses) conduct price discovery for establishing settlement prices using the following mechanisms:
 - a. A measure of market activity during settlement periods;
 - b. A survey of market participants;
 - c. An auction-based price determination; and
 - d. A model-based interpolation of prices.
92. Thus, it is reasonable for market participants to expect that their views of fair value can and should be considered by the clearinghouse, as DRW's were here.

⁸² As noted in "Challenges of Price Discovery in Illiquid Commodity Markets: A White Paper about Pricing Minor Metals," *Ferro-Alloys and Rare Earths*, February 2014, Metal-Pages, Ltd, price discovery in illiquid commodity markets can rely "on canvassing a wide range of market participants by telephone or via electronic communications such as email." See also Green, Richard C., Li, Dan, and Schürhoff, Norman. "Price discovery in illiquid markets: Do financial asset prices rise faster than they fall?" *Journal of Finance* 65.5 (2010): 1669-1702.

⁸³ For instance, see IDCH Rulebook, p. 100.

D. IDCH's Actions Indicate DRW's Bids Enhanced Price Discovery

93. In light of the importance of price discovery to exchanges and clearinghouses, it makes no economic sense for IDCH to incorporate DRW's bids into the Three Month Contract's settlement prices unless IDCH itself understood that these bids reflected true economic value and were more "fair and appropriate" than the Corresponding Rates.⁸⁴ It is my understanding that, on or about December 15, 2010 IDCH (in response to DRW's inquiry into why its bids for the Three Month Contract placed through a voice broker were not being incorporated into the IDEX Curve) told DRW to quote directly into the electronic platform if it wanted its bids considered for incorporation into the IDEX Curve.⁸⁵ IDCH subsequently provided a list of third party vendors that could facilitate DRW's transmission of bids directly to the electronic platform.⁸⁶ These actions by IDCH hardly suggest that DRW's bids were at artificial prices, but rather suggest that it was encouraging DRW to engage in price discovery—*i.e.*, encouraging DRW to contribute electronic quotes as a legitimate source of supply or demand for the Three Month Contract.
94. Following IDCH's recommendation, DRW hired Sky Road, LLC to develop a platform that would enable DRW to place bids on the Three Month Contract electronically.⁸⁷ Subsequently over an extended period of months, IDCH started incorporating DRW's bids into its settlement prices. If incorporating these bids established artificial prices, as

⁸⁴ IDCH Rulebook, p. 100.

⁸⁵ DRW Letter to IDCG, Investigation Number IDCH II 2011-1, February 18, 2011.

⁸⁶ Email from IDCG to DRW, December 20, 2010, D0165286.

⁸⁷ Complaint ¶¶47-48.

alleged in the Complaint, then IDCH was acting contrary to its own economic incentive to establish prices that better reflect fair value.

95. Further, in a February 18, 2011 letter from DRW to IDCH explaining its bidding, DRW asked IDCH to let DRW know if there was any problem with the bids it is posting.⁸⁸ The fact that IDCH apparently did not report any problem and continued to incorporate DRW's bids indicates that it reviewed the information it received, deemed it a valid source of price discovery, and thus concluded that it was appropriate to incorporate DRW's bids into its settlement curve.

XI. THERE IS NO BASIS FOR ALLEGING THAT DRW MANIPULATED MARKET PRICES OR MADE AN ILLICIT PROFIT

A. DRW's Bids Were Consistent with Economic and Financial Theory and Thus DRW Would Have Wanted to Transact at the Prices it Bid

96. As documented above, DRW's bids on the Three Month Contract were in line with rational economic models of the fair value of the contract. Both valuations that I conducted under the Hull-White One-Factor model described above yield premiums over the Corresponding Rates consistent with the explanations DRW has made for its bids. The premiums over the Corresponding Rates reflect the NPV and convexity effects that DRW maintained to be relevant in the valuation of the cleared Three Month Contract.
97. In fact, valuation analyses performed in Section VIII of this report confirm the soundness of the previous assessment of the Three Month Contract provided by Cont *et al.* (2011). The NPV and convexity premium illustrated in those analyses approximates

⁸⁸ DRW Letter to IDCG, Investigation Number IDCH II 2011-1, February 18, 2011.

the premium provided in the Cont *et al.* (2011) illustrations. The estimated premium increases with longer term tenors and varies over time, as theory would predict. These results establish that DRW's bids submitted during the Settlement Period represented a closer approximation of fair value for the Three Month Contract than did the Corresponding Rates.

98. Moreover, these results support my opinion that DRW acted with rational economic behavior for speculation and price discovery. Any rational market participant who valued the Three Month Contract as DRW did would have had the incentive to produce bids at higher rates than the Corresponding Rates, to try to attract a potential counterparty. At small premiums above the OTC interest rate swap curve, DRW's bid prices stood out as the best bids. According to DRW's pricing model, its bids were generally at or below its view of fair value, and, as such, the bids held the possibility of attracting profitable trades for DRW.
99. Contrary to the CFTC's claim that DRW's bids created prices not reflecting legitimate supply or demand, my empirical results show otherwise. Based on my estimations, DRW's bids, while higher than the Corresponding Rates, were largely lower than the fair value rates. If other investors were using models similar to those employed by DRW, they likely would have viewed many of DRW's bids as too low. Despite the fact that DRW's bids were higher than the Corresponding Rates, an investor with a similar model would not be inclined to sell at rates below fair value. In this regard, the dearth of transactions against DRW's bids indicates that these bids were in fact valid and not at artificial prices by any means. To have ignored DRW's bids and defaulted to the Corresponding Rates would have been inappropriate and ultimately artificial.

100. In fact, my empirical work in Section VIII shows that DRW's bids were in fact closer to fair value than were the Corresponding Rates. While the CFTC advocates the use of OTC interest rate swap prices as a simple benchmark, this benchmark is flawed.⁸⁹ As noted in Section VII and verified empirically in Section VIII above, the fair value of the cleared Three Month Contract consists of the Corresponding Rate plus the NPV and convexity effects. My estimates of these latter two effects comport well with DRW's explanations that its bids more closely represented fair value for the Three Month Contract than a simple comparison with Corresponding Rates.
101. By bidding at rates higher than the Corresponding Rates, it appears that DRW's bids were the best available to IDCH. By quoting competitively, both during the trading day generally and during the Settlement Period, DRW stood ready to trade against less sophisticated market participants or those with a different view on the value of the Three Month Contract. This behavior stands the test of economic rationality, and my opinion is not tempered by the fact that some of DRW's bids were made during the Settlement Period. To the contrary, as described in Section X above, such behavior of competitive bidding based on informed judgment is consistent with price discovery in the marketplace, something traders, exchanges, clearinghouses and, more importantly, regulators should - and do - encourage.

⁸⁹ "The [Three Month Contract] Jefferies entered into through IDCH were not economically equivalent to uncleared [OTC Interest Rate] Swaps of the same terms" and "IDCG's representations that its [Three Month Contracts] were "economically equivalent" to those of OTC [Interest Rate] Swaps were false in that the absence of a PAI adjustment in its [Three Month Contract] made it inappropriate to price its [Three Month Contract] identically to OTC [Interest Rate] Swaps; in addition, the [Three Month Contract] exposed Jefferies to a substantially different risk profile than in the case of OTC [Interest Rate] Swaps of identical notional value and maturity." See Findings of Fact and Conclusions of Law, January 9, 2013, ¶7 and ¶29, JEF-CFTC-476403-33.

102. The pattern of swap futures pricing from OTC interest rate swap curves to a futures-specific curve that incorporates the convexity effect is not new. Gupta and Subrahmanyam (1999) thoroughly explore whether a convexity correction has been efficiently incorporated into interest rate swap pricing over time in the four major international currencies. They find evidence that swap futures contracts were mispriced during the earlier years of the study when the adjustment for convexity effect was ignored (and simple OTC interest rate swap rates were applied), but this mispricing was gradually eliminated by incorporating the adjustment for convexity effect in currency swap futures pricing over time. They surmise the slow change to incorporating the adjustment for convexity effect to market frictions as well as internal or external constraints on bank participation in futures markets. Just as in the Three Month Contract, eventually the market learned.
103. I conclude that DRW did not manipulate market prices or create artificial prices by bidding above OTC interest rate swap rates during the Three Month Contract's Settlement Period. My analysis supports DRW's contention that each of its bids reflected proprietary analysis of the fair value of the Three Month Contract. DRW's bids did not create artificial prices, but rather reflect attempts to transact at what would have been largely profitable trades and to contribute to price discovery by bringing settlement prices closer to true value.

B. DRW's Bids Reflected a Willingness and Desire to Trade

104. The CFTC's contention that DRW's bids created artificial prices is incorrect. The CFTC makes much of the fact that few, if any trades were consummated against DRW's bids. Based on my empirical assessment of these bids, however, DRW stood ready to trade at the prices it was bidding and, as a result of its analysis, believed that it could have made

money if its bids were hit. Bids on the IDCG market were firm, committing the bidder to buy at the posted price and quantity. Overall, DRW posted bids for an average of nearly 47 minutes. Further, DRW's bids during the Settlement Period were posted for an average of more than 17 minutes, longer than the settlement window itself and a substantial period of time to be recognized (and traded against) by other market participants. These time frames are also long enough to expose DRW to the risk of short-term market movements.

105. The CFTC's assertion that DRW placed bids that "DRW knew would never be accepted" is also false. DRW's bids were higher than the Corresponding Rates, offering a premium to trade in the Three Month Contract above what the OTC interest rate swap market was quoting. DRW's bids were competitively priced (relative to the Corresponding Rates) to be attractive to prospective sellers. While, according to DRW, its bids were (rationally) below what it perceived as fair value, leaving room for a profit, traders who valued the NPV and convexity effects differently may well have found DRW's bids attractive. For instance, prices from the Hull-White One-Factor model that I have estimated here do not perfectly coincide with each other or with DRW's bids. Likewise, estimates using related single-or multi-factor Heath-Jarrow-Merton models are likely to yield different estimates as well.⁹⁰

106. Moreover, at least one of DRW's bids attracted trading interest from MF Global. I understand that DRW's posted bid drew the attention of MF Global, which led to negotiations about prices for a larger trade that was agreed to at a much higher rate than the Corresponding Rate. This trade was ultimately "busted" (it never cleared) at the

⁹⁰ See Henrard (2012) and Kennedy, Gary, "Swap Futures in HJM One-Factor Model," SSRN 1648419, (2010). Available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1648419.

request of MF Global.⁹¹ This is consistent with the fact that DRW's bids, which, while substantially higher than the Corresponding Rates, were at that time still well below fair value. Thus, not only does this confirm that the Corresponding Rates were not a viable basis to settle the Three Month Contract, it also bolsters IDCH's decision to continue to use DRW's electronic bids in its settlement curve after the busted trade.

107. As an indirect counterparty to DRW's long position in the Three Month Contract, Jefferies acknowledged that leaving short positions (entered into at the Corresponding Rate) in place through maturity would "eat away capital in the form of initial margin postings."⁹² To compensate for this fact, Three Month Contract prices should have been higher than OTC interest rate swap prices. DRW's bids were indeed higher and reflected a true willingness to trade at its publicly posted prices and quantities (*i.e.*, notional amounts).

C. DRW's Bids Provided Market Liquidity and Contributed to Price Discovery

108. DRW's bids were open for an extended duration (almost 47 minutes, on average), were posted throughout the trading day (only 40% were new bids during the Settlement Period), and were for a substantial size. As such, DRW's bids provided much-needed market liquidity to the Three Month Contract. In fact, by directly incorporating the NPV and convexity effects into its bids, DRW served the market well, by actively participating in price discovery.
109. As noted above, DRW's bids during the Settlement Period stood out as the most important means of price discovery. Given that settlement procedures are closely

⁹¹ Communications between NewEdge and DRW, February 2, 2011, D0000253-286.

⁹² Findings of Fact and Conclusions of Law, January 9, 2013, ¶46, JEF-CFTC-476403-33.

monitored and strictly enforced, the settlement period often reveals the most informative supply and demand data of the trading day. As such, prices during settlement periods are considered the most robust prices of the day and are the most widely disseminated prices of the day (and, here, were utilized by IDCH for daily margin calculations). Importantly, DRW's bids during the Settlement Period were posted for an average of more than 17 minutes, longer than the settlement window itself, and clearly contributed to price discovery in this window.

110. It is my understanding that there were few, if any, electronic bids for the Three Month Contract during the Settlement Period or otherwise prior to DRW's bidding activity during the Relevant Period. DRW's bids during the day, and particularly during the Settlement Period, contributed greatly to price discovery for the Three Month Contract.

D. DRW's Profit Is a Result of a Trading Strategy Based on the Assessment of the Fair Economic Value of the Three Month Contract and Not a Result of its Electronically Submitted Bids

111. Regardless of whether IDCH continued to establish settlement prices based on the Corresponding Rates (as it did before the Relevant Period) or it moved its settlement curve toward fair value (as it did during the Relevant Period), DRW would have made nearly the same profits by virtue of originally entering into the long side of the Three Month Contract at or near the Corresponding Rates.
112. As acknowledged by Jefferies, the indirect short counterparty to DRW in the Three Month Contracts, holding its short positions through maturity would have "eat[en] away capital in the form of initial margin postings."⁹³ As Christopher Bury, Jefferies'

⁹³ Findings of Fact and Conclusions of Law, January 9, 2013, ¶46, JEF-CFTC-476417 (quoting Christopher Bury).

Head of U.S. Rates, Trading, and Sales, and Garry O'Connor, IDCH's CEO during the Relevant Period, indicated, the erosion of capital would accrue over the life of the Three Month Contract, even if its settlement rates had remained at the Corresponding Rates (except the loss would have accrued more slowly over time due to the lack of a PAI adjustment).⁹⁴ This erosion would occur as long as the daily process of clearing generated cash flows via variation margin over the life of the contract.

113. Jefferies ultimately opted to pay DRW in excess of \$15 million to unwind its open positions, rather than hold those positions through maturity, despite the fact that, on August 11, 2011 the "closing value of economically equivalent OTC [Interest Rate] Swaps" was just above \$7.0M in favor of Jefferies.⁹⁵ This is because Jefferies, by that time, realized that DRW's valuation of the impact of the convexity and NPV effects on the Three Month Contract was accurate⁹⁶ and, thereby, acknowledged that the Three Month Contract should not have been priced based on the Corresponding Rates. Thus, Jefferies' payment appears to be a rational decision to exit a position in the Three Month Contract that was entered into at or near the disadvantageous Corresponding Rates. In no way does it represent DRW's profits from allegedly manipulated prices.

114. The fact is that the Three Month Contract is only accurately priced with the NPV and convexity effects included. The Three Month Contract was simply worth more than the underlying OTC interest rate swap contract because of the NPV and convexity effects. The IDEX Curve should have priced in these effects to represent true supply and demand for the Three Month Contract.

⁹⁴ Findings of Fact and Conclusions of Law, January 9, 2013, ¶46, JEF-CFTC-476417.

⁹⁵ Findings of Fact and Conclusions of Law, January 9, 2013, ¶63, JEF-CFTC-476421.

⁹⁶ Deposition of Christopher Bury, May 29, 2015, pp. 26-27.

115. As discussed extensively above, the process of learning and of adjusting the IDCH curve to prices where supply or demand is balanced is, in economic terms, simply the price discovery process. The process did not generate profits for DRW, but only moved profits forward in time as the market learned where supply or demand would be balanced.

XII. ANALYSIS OF MR. MACLAVERTY'S REPORT

116. Mr. MacLavery states he was asked by CFTC's counsel to opine on several aspects of the current matter by, among other things, (i) providing a general discussion of derivatives especially interest rate swap futures contracts; (ii) conducting an analysis of the Three Month Contract; (iii) discussing DRW's trading activity; and (iv) performing a profit and loss analysis on DRW's trades.⁹⁷

117. Having evaluated the opinions expressed by Mr. MacLavery, I find several important flaws in his analysis that lead to incorrect conclusions. Mr. MacLavery's overall approach and analysis are flawed by virtue of making unreasonable assumptions and unsupported and incorrect statements. I disagree with Mr. MacLavery's findings because he:

- makes inappropriate assumptions regarding settlement prices of the Three Month Contract that affect his analysis;
- makes flawed and unsupported statements suggesting that DRW's bids reflected artificial prices;
- provides an inadequate and overly simplistic approach, failing to support his arguments with reliable empirical analysis;

⁹⁷ MacLavery Report ¶¶10-14.

- makes incorrect statements regarding the convexity effect and largely ignores the NPV effect;
- uses the unsupported and inappropriate Corresponding Rates without economic justification; and
- makes incorrect and unsubstantiated statements regarding price discovery.

A. Mr. MacLavery's Assumptions Regarding Settlement Prices Are Without a Factual Basis

118. Mr. MacLavery assumes that, absent DRW's bids, the Three Month Contract's daily settlement prices would have been set at the Corresponding Rates.⁹⁸ This assumption, however, is flawed for two reasons. First, as noted above, prices of non-cleared OTC interest rate swaps are, and should be, distinctly different from prices of cleared contracts such as the Three Month Contract in question here. Indeed, the existence of the NPV and convexity effects leads to these valuation differentials as a matter of fact (and not one of "potential" as Mr. MacLavery has opined). Because here, as noted above, IDCH had an obligation to ensure that its daily settlement rates were a "fair and appropriate reflection of the market,"⁹⁹ it would not have "been prudent from a risk management perspective" for IDCH to continue setting its daily settlement prices to the Corresponding Rates.¹⁰⁰ Second, I have seen no evidence to suggest that, if DRW had

⁹⁸ MacLavery Report ¶¶30-32.

⁹⁹ IDCH Rulebook, p. 100.

¹⁰⁰ Email exchange between Michael Dundon and Rae Etherington regarding IDCH Adjustment of Revaluation Curve, January 2, 2011, JEF-CFTC-474513-514.

stopped injecting bids during the Settlement Period, IDCH would have necessarily reverted back to settling the Three Month Contract at Corresponding Rates.¹⁰¹

B. Mr. MacLavery's Statements that DRW's Bids Reflected Artificial Prices Are Wrong and Unsupported

119. While Mr. MacLavery asserts that DRW's bids were artificial, he provides no evidence whatsoever that this is true. Rather, he simply compares the Corresponding Rates to the bids posted by DRW and notes that they are different.¹⁰² This, however, does not lead to the conclusion that DRW's bids failed to reflect legitimate supply or demand for the Three Month Contract. And, more importantly, my own analysis of the Three Month Contract, which Mr. MacLavery did not perform, confirms that DRW's bid prices are actually closer to the fair value of the Three Month Contract than any price previously or concurrently derived from non-cleared OTC interest rate swap transactions (See discussion of the NPV and convexity effects in Section VII).
120. A simple assertion that prices are different, without a thorough analysis of why they might be, cannot be a valid justification for assessing an artificial price. In this regard, I find that Mr. MacLavery's conclusion on artificial prices is misleading and completely unreliable from both a scientific and economic view. A rigorous approach to determining artificiality would be to compute an actual value for the Three Month Contract, and compare it to DRW's bids, something I have done in this report, and something DRW did and later shared with the marketplace.¹⁰³ Apparently, Mr.

¹⁰¹ In fact, Garry O'Connor testified to the contrary. See Deposition of Garry O'Connor, September 18, 2012, p. 240-41. See also Exhibits 4A through 4G.

¹⁰² MacLavery Report ¶54 and ¶69.

¹⁰³ See Cont *et al.* (2011).

MacLavery did not even check DRW's computations as reported in Cont *et al.* (2011), let alone do his own computations.

1. No Justification for Finding Artificial Prices

121. From a rational economic standpoint (the standard applied in U.S. financial regulatory bodies), an artificial price is a price that deviates from what true supply or demand would otherwise dictate. In this case, with the exception of DRW's bids, observed supply or demand for the Three Month Contract was virtually nil because the Three Month Contract did not trade actively on the exchange. However, we can rationally conduct a thought experiment to ascertain whether DRW's bids might have created an artificial price.
122. First, consider whether incorporating DRW's bids into prices results in prices that were artificially low. This case is easily discarded. DRW's bids were placed at higher yields than the Corresponding Rates, thus if DRW's bid prices were artificially low, the Corresponding Rates were even more so.
123. Second, consider whether prices were artificially high (which the CFTC seems to imply without actually saying so). The fact that proper pricing mechanisms, which consider the NPV and convexity effects, would lead to higher prices than the Corresponding Rates creates a somewhat larger hurdle to prove that prices were "artificially high." Nonetheless, even without assessing these effects, we can think through the consistency and rationality of Mr. MacLavery's assertions. If prices were "too high" relative to the true market price, then the lack of trading against DRW's bids undermines his assertions—a rational response to a quote that is "too high" would be for another trader to take the other side to reap the benefits of this artificial price. The fact that none of

DRW's bids were directly hit does not support Mr. MacLaverty's assertion, but rather undermines his case.

2. Failure to Understand DRW's Bids

124. DRW's bids were justified by rational economic behavior. The price of the Three Month Contract involved the value of a non-cleared swap contract plus the estimated value of the NPV and convexity effects. Given that the cash flows involved with daily clearing gave rise to differences between the non-cleared swap and its cleared counterpart, a rational trading strategy would involve bidding at some price above the non-cleared swap price but at or below the fair value of the non-cleared swap price plus the value of the NPV and convexity effects. Purchases at any price below fair value would represent a rational economic motive to transact.
125. Moreover, DRW's bids were not cursory in nature. In an era of electronic financial markets, posting a bid for as long as 15 minutes during the Settlement Period (or for 15 minutes during ANY time of the day) represents true liquidity to the market. DRW's bids were not secret, DRW's bids were for substantial size, and, by the trading rules established by IDCH, DRW's bids were firm.
126. Notwithstanding the fact that DRW's bids represented true demand to trade substantial quantities at firm prices, the CFTC (and Mr. MacLaverty) both imply that DRW's bids were only focused on the Settlement Period. By my assessment as shown in **Exhibit 5**, a full 60% of DRW's bids were made outside the Settlement Period, at prices similar to the bids made during the Settlement Period.

C. Mr. MacLavery Fails to Support his Arguments with Reliable Empirical Analysis

127. As noted above, Mr. MacLavery simply compares DRW's bids to the Corresponding Rates (and to earlier periods when the IDCG settlement prices only included reference to the Corresponding Rates since no traders were bidding during the Settlement Period). Below, I critique this comparison on multiple levels.
128. Firstly, Mr. MacLavery fails to conduct a meaningful valuation analysis of the Three Month Contract. He simply repeats the obvious fact that prices quoted by DRW during the Settlement Period differed from the Corresponding Rates. Secondly, his report repeatedly and erroneously refers to the "potential" for the convexity effect.¹⁰⁴ The NPV and convexity effects are real and impacted the value of the Three Month Contract regardless of whether the contract was settled at fair value or the Corresponding Rates. Thirdly, Mr. MacLavery's assertions are made without any meaningful attempt to quantify the value of the NPV and convexity effects that existed during the time in question. I have taken the care to estimate those values in Section VIII of this report and found that DRW's bids are all well within reasonable price ranges that might be expected given market conditions at the time.¹⁰⁵

D. Mr. MacLavery's Statements Regarding "Potential" Convexity Effect Are Incorrect and Unsupported

129. Mr. MacLavery's report demonstrates his lack of understanding of how the NPV and convexity effects affect cleared interest rate futures markets. He does not provide any definition of the convexity effect, nor does he discuss the magnitude of, sources of, or

¹⁰⁴ MacLavery Report ¶7 and ¶54.

¹⁰⁵ See Section VIII where I explain how I calibrated the Hull-White model using publicly available data on short- and long-term interest rates and prices of interest rate swaptions during the Relevant Period.

results from the convexity effect. Mr. MacLavery also does not address the NPV effect in his report.

130. Further, he fails to recognize that the NPV and convexity effects are not some hypothetical or potential market outcome, but rather are the result of interest lost or gained on payments made via variation margin accounts, a structural outcome from margining processes. It is a real and accepted process in various other markets that other exchanges (like LCH.Clearnet) address in their clearing rules.
131. Mr. MacLavery's claims that DRW allegedly profited from a "potential convexity bias" reflect a complete misunderstanding of the NPV and convexity effects. As noted above, the interest lost or gained on payments made via the variation margin accounts creates a structural reason that cleared futures contracts (like the Three Month Contract) deviate in value from their non-cleared OTC interest rate swap counterparts. As shown in Section VII, the convexity effect has been known to exist back to at least 1994 when Burghardt and Hoskins published "The Convexity Bias in Eurodollar Futures."¹⁰⁶
132. The CFTC further muddles the subject when discussing "at least two pre-conditions" for the convexity effect to exist. The CFTC wrongly asserts that the convexity effect depends on two pre-conditions: "(a) market knowledge of the benefit accruing to those paying fixed rates in an interest rate contract; and (b) collective action by the shorts demanding higher rates in compensation."¹⁰⁷ No such "pre-conditions" exist and indeed are nowhere found in models of the convexity effect.

¹⁰⁶ Burghardt, Galen, and Hoskins, William (1994), "The Convexity Bias in Eurodollar Futures," Dean Witter Institutional Futures Research Note.

¹⁰⁷ Complaint ¶22.

133. Rather, a properly functioning market should either account specifically for the NPV and convexity effects in the contracts themselves (as do LCH.Clearnet and the CME Group through the PAI) or should incorporate the impact of these effects on value into settlement prices (as DRW's bids did). The CFTC's assertion that "a collective action by the shorts demanding higher rates in compensation" is required only serves to bolster DRW's defense. No short directly took the opposite side of DRW's bid, suggesting that the "collective action" was only to withhold trades because *the compensation offered by DRW was not high enough (not far enough away from the Corresponding Rates)*. In this light, DRW's bids, rather than being artificially high, could easily be interpreted as still being below-market, despite the fact that they were higher than the Corresponding Rates. In the face of this market evidence, and the NPV and convexity effects in general, it would have been "artificial" for IDCH to ignore DRW's bids and continue to default to the Corresponding Rates.
134. Given that the NPV and convexity effects are determined structurally by the exchange of variation margins on cleared instruments and collateral on non-cleared instruments, respectively, these effects can be counteracted directly, with PAI, for instance. In the absence of a formal PAI or any other adjustment feature, market prices are likely to exist naturally within a range of prices between the non-cleared OTC interest rate swap price and an unknown, but higher cleared futures contract price. The width of this band will thus be determined by the changing correlation structure between interest rates and interest rate swaps (and the duration of the contract if correlations change differentially across the term structure) and the volatility of interest rates (which affects the relative difference between margins and collateral).

E. Mr. MacLavery's Statements Regarding Price Discovery Are Wrong and Unsubstantiated

135. Mr. MacLavery states that DRW's bids did not aide in price discovery or add liquidity to the Three Month Contract.¹⁰⁸ These statements are erroneous. Rather, DRW's bids served an essential role in the price discovery process for the Three Month Contract, as described in Section X. Similarly, Mr. MacLavery ignores the fact that exchanges and clearinghouses, such as IDCH, have strong incentives for price discovery to take place in their venues and encourage traders, including DRW, to participate in price discovery by posting quotes.

XIII. CONCLUSIONS

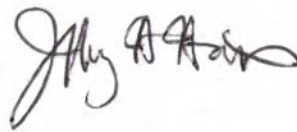
136. Having analyzed the materials set forth in Appendix C and conducted the analysis described herein, there is no support for the CFTC's allegations that DRW manipulated or attempted to manipulate the market, "unlawfully placed orders for certain futures contracts with the intent to move the prices of the contracts in their favor, to increase the value of the futures contract positions they held in their portfolio," or employed any illegal or manipulative scheme to create artificial prices.¹⁰⁹ To the contrary, DRW's bids in the Three Month Contract were based on proprietary valuation methods, which I have confirmed comport to my own estimates of value for the Three Month Contract. Moreover, DRW's bids were legitimate offers to purchase the security, posted at higher, more attractive rates (to sellers) than the Corresponding Rates, and did not therefore represent "artificial prices" as alleged.

¹⁰⁸ MacLavery Report, ¶75.

¹⁰⁹ Complaint ¶1.

137. DRW's bids on the Three Month Contract reflected the NPV and convexity effects and therefore represent a clear example of proprietary pricing methods contributing to price discovery in the Three Month Contract, at prices more closely representative of true supply or demand for the Three Month Contract than the Corresponding Rates.
138. The NPV and convexity effects affected the value of DRW's open positions regardless of whether IDCH settled the Three Month Contract to prices that reflected DRW's bids or to the Corresponding Rates. DRW profits stemmed from the fact that DRW entered into a long position on the Three Month Contract at prices substantially below the Three Month Contract's fair value.

Executed on July 27, 2015

A handwritten signature in black ink, appearing to read "Jeffrey H. Harris", is written over a light gray rectangular background.

Jeffrey H. Harris, Ph.D.

Exhibit 1
Characteristics of the Three Month Contract

Three Month Contract	IDEX USD Interest Rate Swap Futures Contract.
Exchange	NASDAQ OMX Futures Exchange.
Clearinghouse	International Derivatives Clearinghouse, LLC.
Settlement	Cash settled.
Schedule	The Exchange at any given time may list for trading the Three Month Contract having maturities from one day to thirty years, with a contract maturing on every calendar day. The Maturity Date of each individual Three Month Contract shall be established by the Exchange on the date each such contract is listed by the Exchange.
Daily Settlement Price	Each open position is valued by the Clearinghouse at the end of each trading day by valuing each leg of the cash flows of the contract (fixed and floating) according to discount factors generated by the IDEX Curve. Each Trading Day, the Daily Settlement Price shall be established by the Clearinghouse based upon the IDEX Curve that corresponds to the fixed rate portion of the swap. A net present value of the position will be determined and set as the Daily Settlement Price. Notwithstanding the preceding sentence, the Clearinghouse may, in its sole discretion, establish a Daily Settlement Price that is a fair and appropriate reflection of the market. The Final Settlement Price shall be the Daily Settlement Price on the Last Trading Day.
Effective Date	2 week days after execution of any individual Three Month Contract, adjusted by the Following Business Day ^[1] convention for New York.
Maturity Date	Final payment date, unadjusted by any Business Day convention, of the Three Month Contract and shall be established by the Exchange on the listing date.
Payment Schedule	Periodic payments on semi-annual basis for the fixed rate payments and on quarterly basis for the floating rate payments. Each payment date will be defined by the Effective Date, the Maturity Date, and the payment frequency of the fixed or floating side, adjusted by the Modified Following Business Day convention for New York and London.
Floating Rate Payment	$(\text{Notional Value}) \times (\text{USD LIBOR}^{[2]}) \times (\text{Actual} / (360 \text{ Accrual Year Fraction}))^{[3]}$
Fixed Rate Payment	$(\text{Notional Value}) \times (\text{Fixed Rate}) \times (30 / (360 \text{ Accrual Year Fraction}))^{[4]}$
Minimum Price Increments	0.001 percent of the fixed leg portion of the Swap.
Last Trading Day	Last Day on which the Exchange is open for the trading of the Three Month Contract preceding the contract's Maturity Date.

Notes:

- [1] Following Business Day Convention means the date will be adjusted to be the first following day that is a Business Day in the locations listed.
- [2] USD 3-month LIBOR rate.
- [3] $(\text{Actual} / (360 \text{ Accrual Year Fraction}))$ means the actual number of days in the interest period in respect of which payment is being made divided by 360.
- [4] $(30 / (360 \text{ Accrual Year Fraction}))$ means the number of days in the interest period in respect of which payment is being made (assuming 30 day months) divided by 360, calculated on a formula basis as follows;
 $\{[360 \times (Y2 - Y1)] + [30 \times (M2 - M1)] + (D2 - D1)\} / 360$,
 where:

Y1 is the year, expressed as a number, in which the start date of the interest period falls.

Y2 is the year, expressed as a number, in which the end date of the interest period falls.

M1 is the calendar month, expressed as a number, in which the start date of the interest period falls.

M2 is the calendar month, expressed as a number, in which the end date of the interest period falls.

D1 is the first calendar day expressed as a number, of the interest period, unless such a number would be 31, in which case D1 will be 30.

D2 is the last calendar day, expressed as a number, of the interest period, unless such a number would be 31 and D1 is greater than 29, in which case D2 will be 30.

The start date of the n^{th} interest accrual period is the Effective Date plus $(n-1) \times (\text{payment frequency of the fixed or floating side as appropriate})$, adjusted by the Modified Following Business Day convention for New York and London.

Sources:

- [1] IDCG IDEX USD Interest Rate Swap Futures Contract Specifications. Available at: http://www.idcg.com/pdfs/IRSF_ContractSpecification.pdf.
- [2] Rules of International Derivatives Clearinghouse, LLC, As of September 1, 2010, p. 100.

Exhibit 2A
Eurodollar Futures Implied Convexity Effect Relative to 7-Year Swap

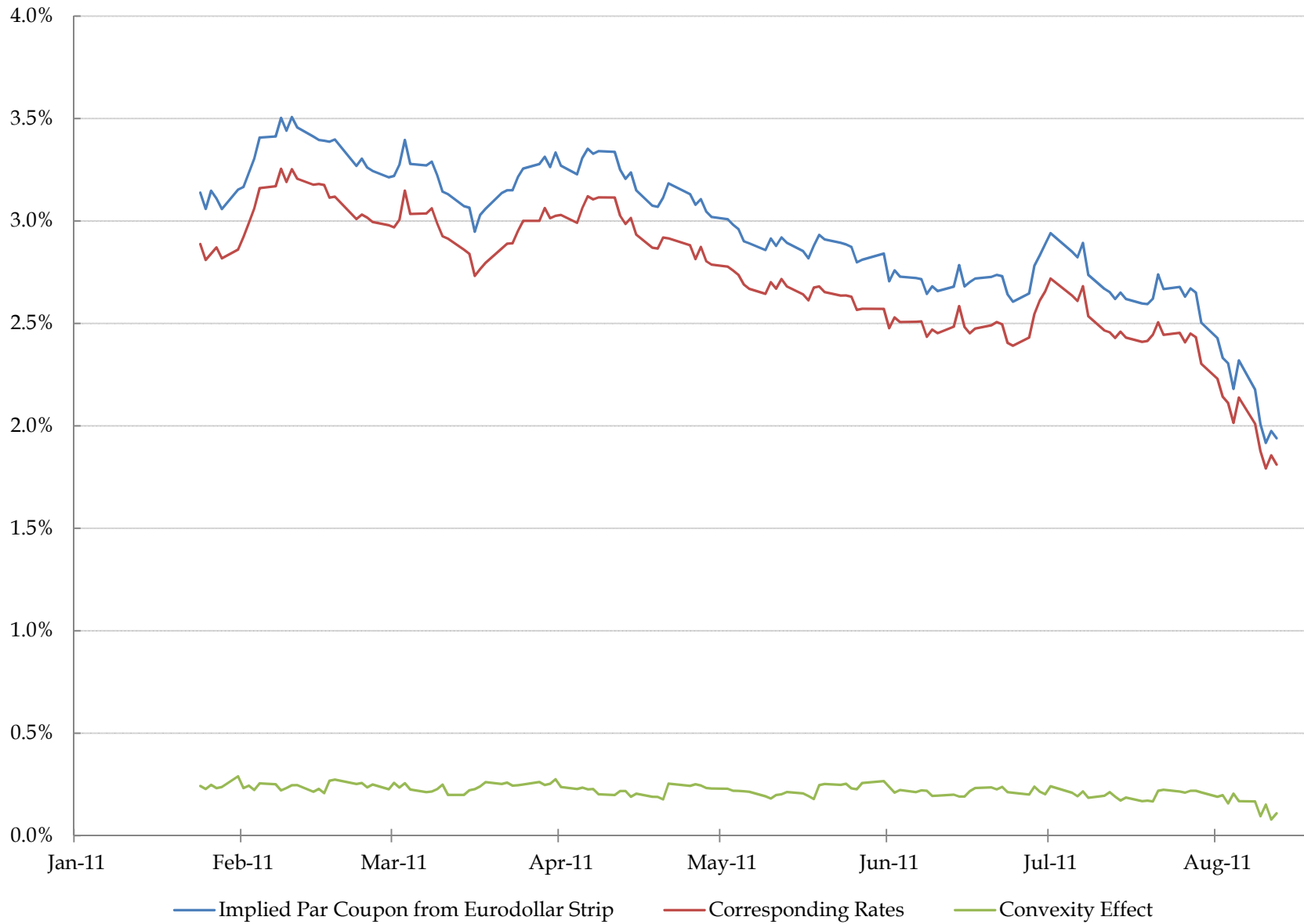


Exhibit 2B
Eurodollar Futures Implied Convexity Effect Relative to 10-Year Swap

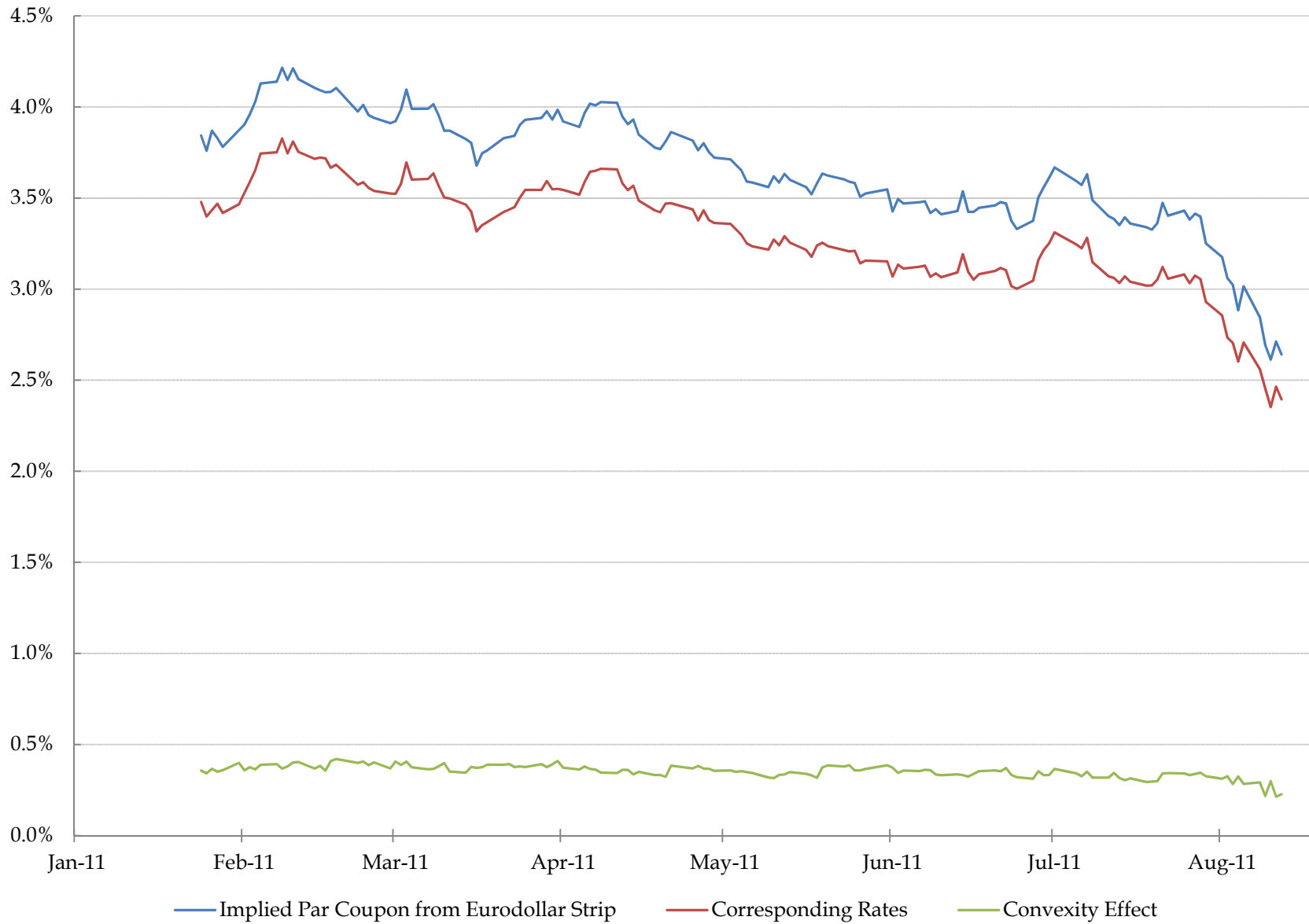


Exhibit 2
Eurodollar Futures Implied Convexity Effect Relative to Swap Rates

Notes:

- [1] Implied Par Coupon from Eurodollar Strip is obtained from par yield curve based on Eurodollar Futures contracts.
- [2] Corresponding Rates are obtained from IDCG. See DRW-IDCG-0000003.xls and Deposition of Garry O'Connor, pp. 211-21, JEF-CFTC472883-85.
- [3] Convexity Effect represents the difference between the Implied Par Coupon and the Corresponding Rates.
- [4] According to the Complaint, DRW entered bids on the Three Month Contract between January 24, 2011 and August 12, 2011.

Sources:

- [1] Deposition of Garry O'Connor, September 18, 2012, JEF-CFTC-472831-920 and Exhibit 74 to the Deposition of Garry O'Connor, JEF-CFTC-474132.
- [2] DRW-IDCG-0000003.xlsx
- [3] Bloomberg, L.P.
- [4] Complaint ¶¶ 3, 40.

Exhibit 3A
Difference of DRW's Bids and Corresponding Rates and Hull-White NPV and Convexity Effects
7-Year Maturity

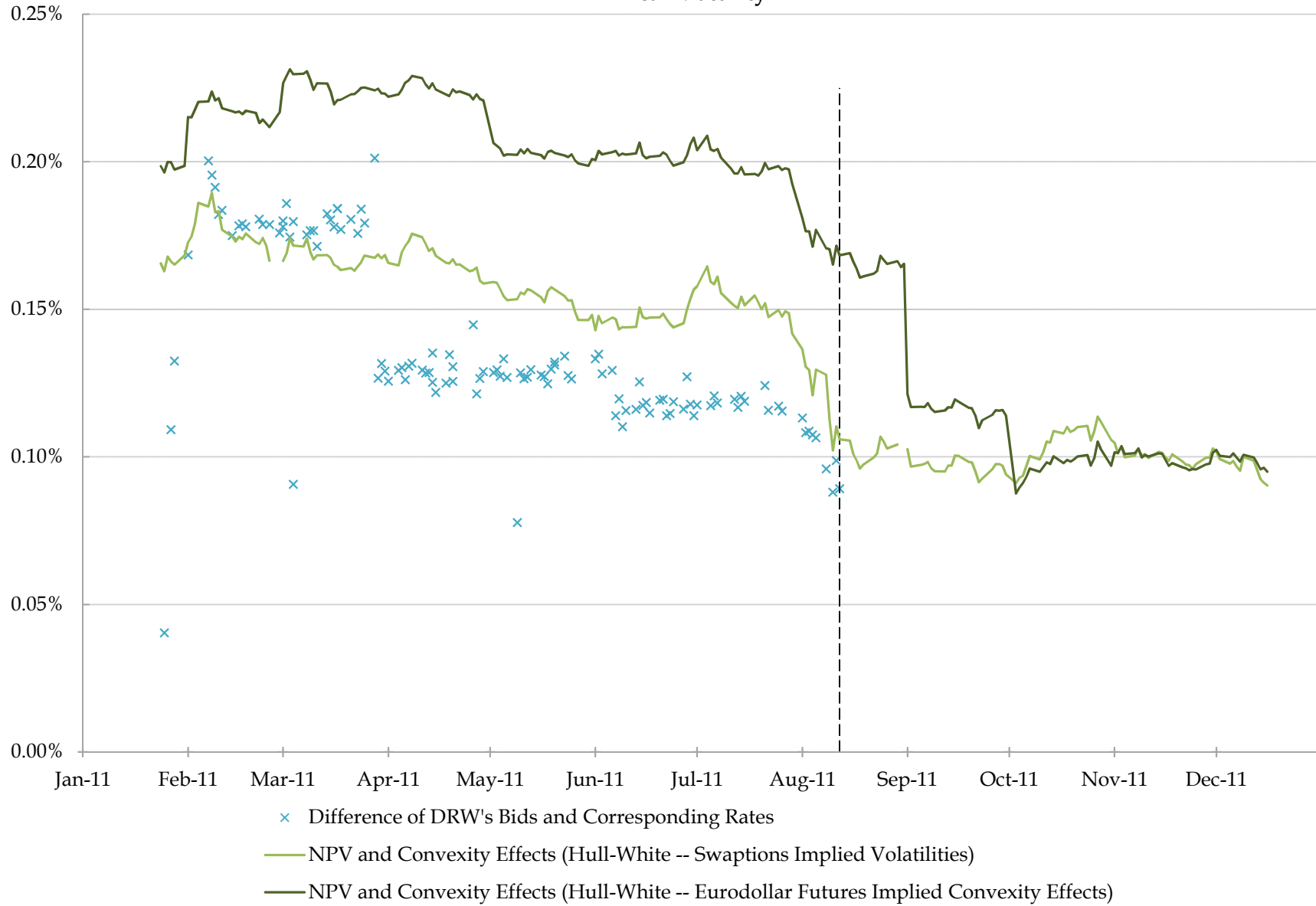


Exhibit 3B
Difference of DRW's Bids and Corresponding Rates and Hull-White NPV and Convexity Effects
10-Year Maturity

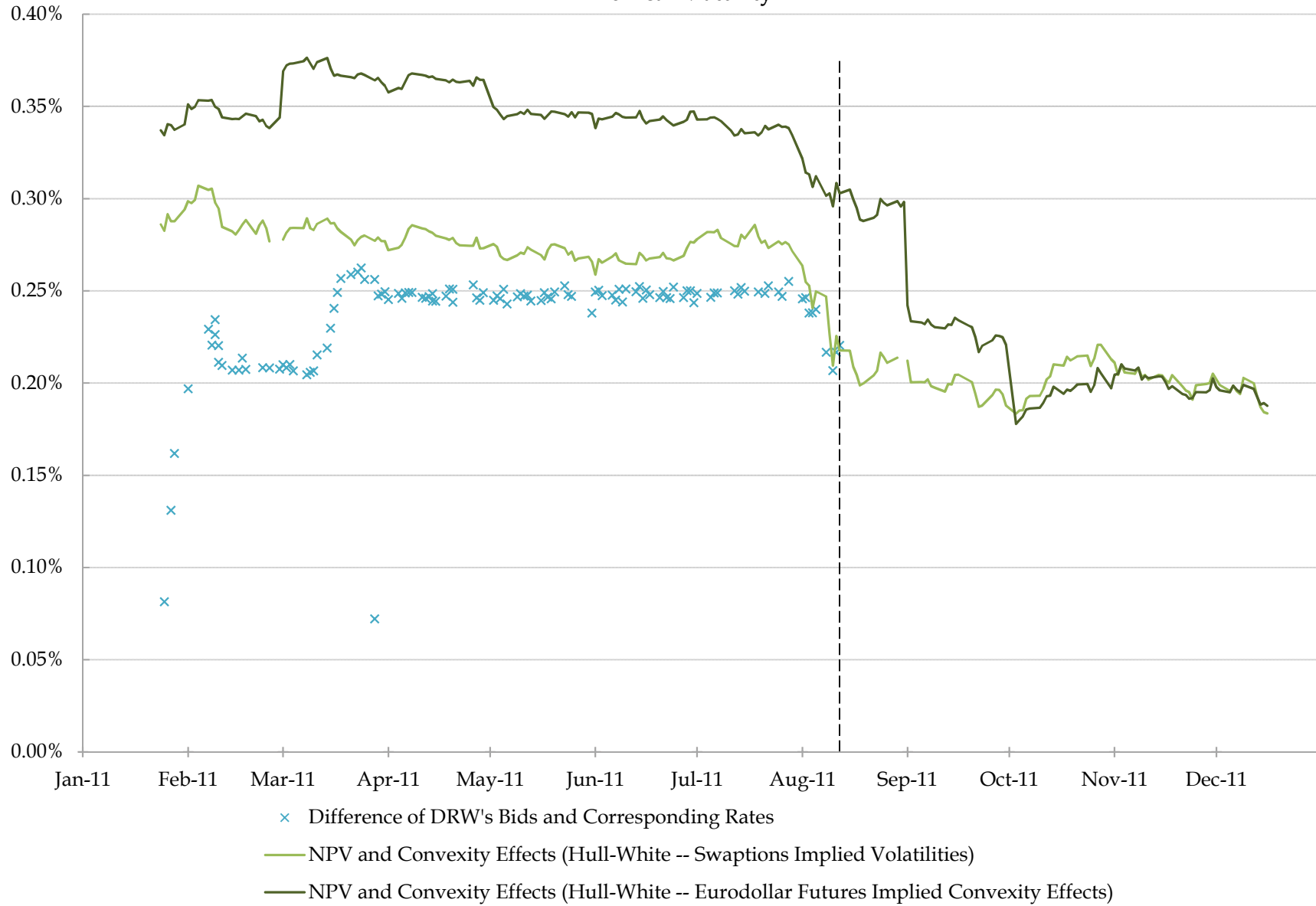


Exhibit 3C
Difference of DRW's Bids and Corresponding Rates and Hull-White NPV and Convexity Effects
12-Year Maturity

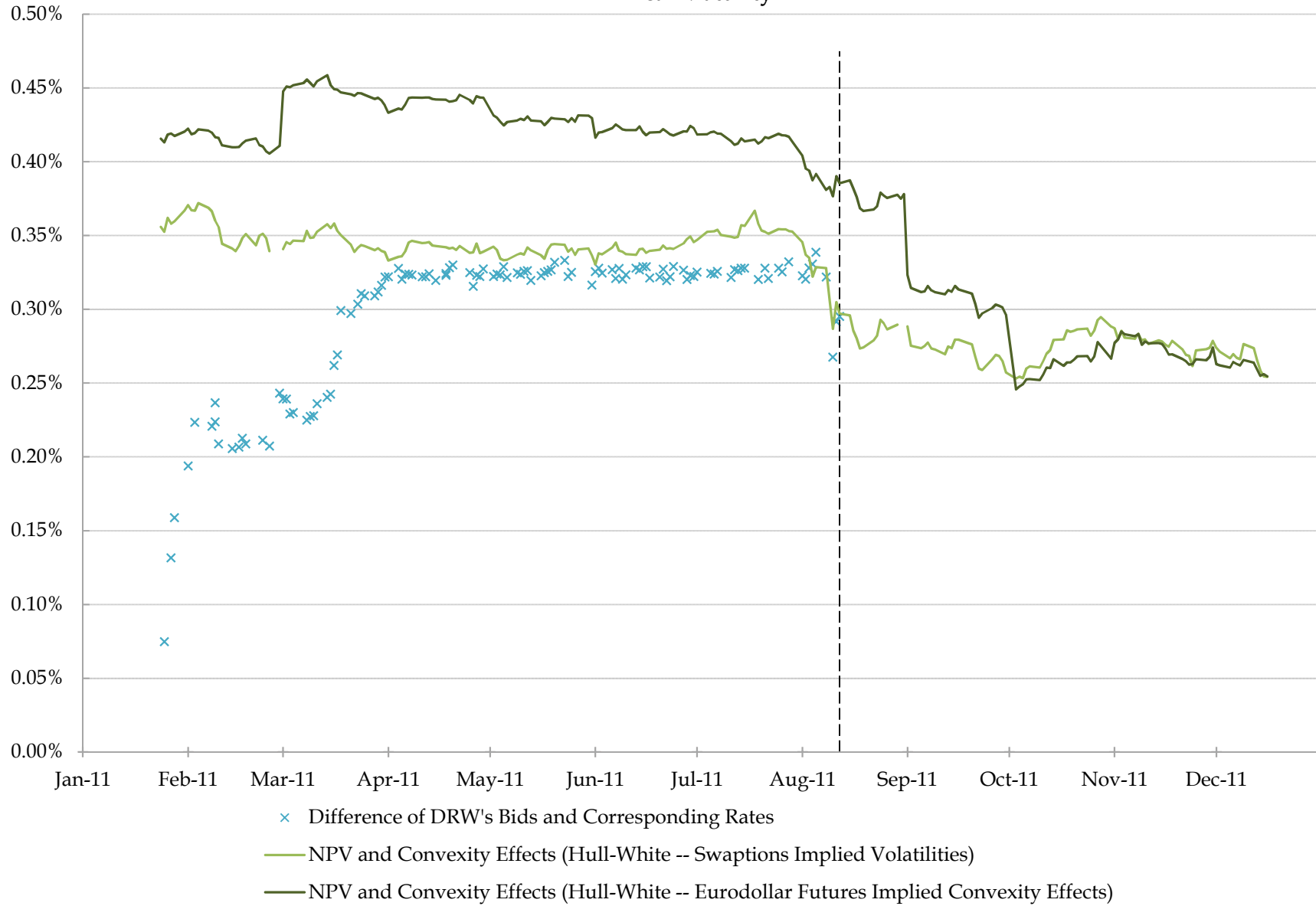


Exhibit 3D
Difference of DRW's Bids and Corresponding Rates and Hull-White NPV and Convexity Effects
15-Year Maturity

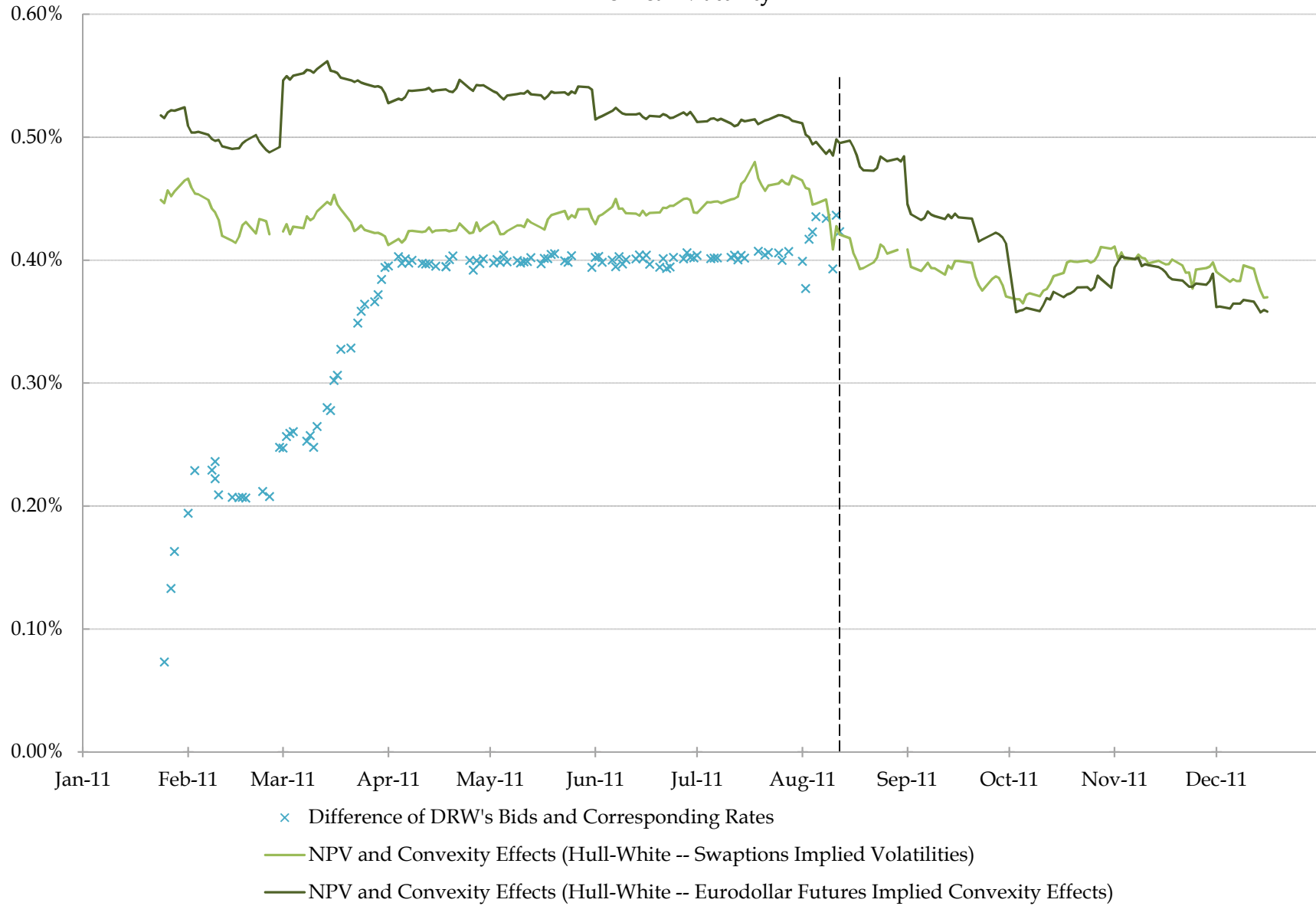


Exhibit 3E
Difference of DRW's Bids and Corresponding Rates and Hull-White NPV and Convexity Effects
20-Year Maturity

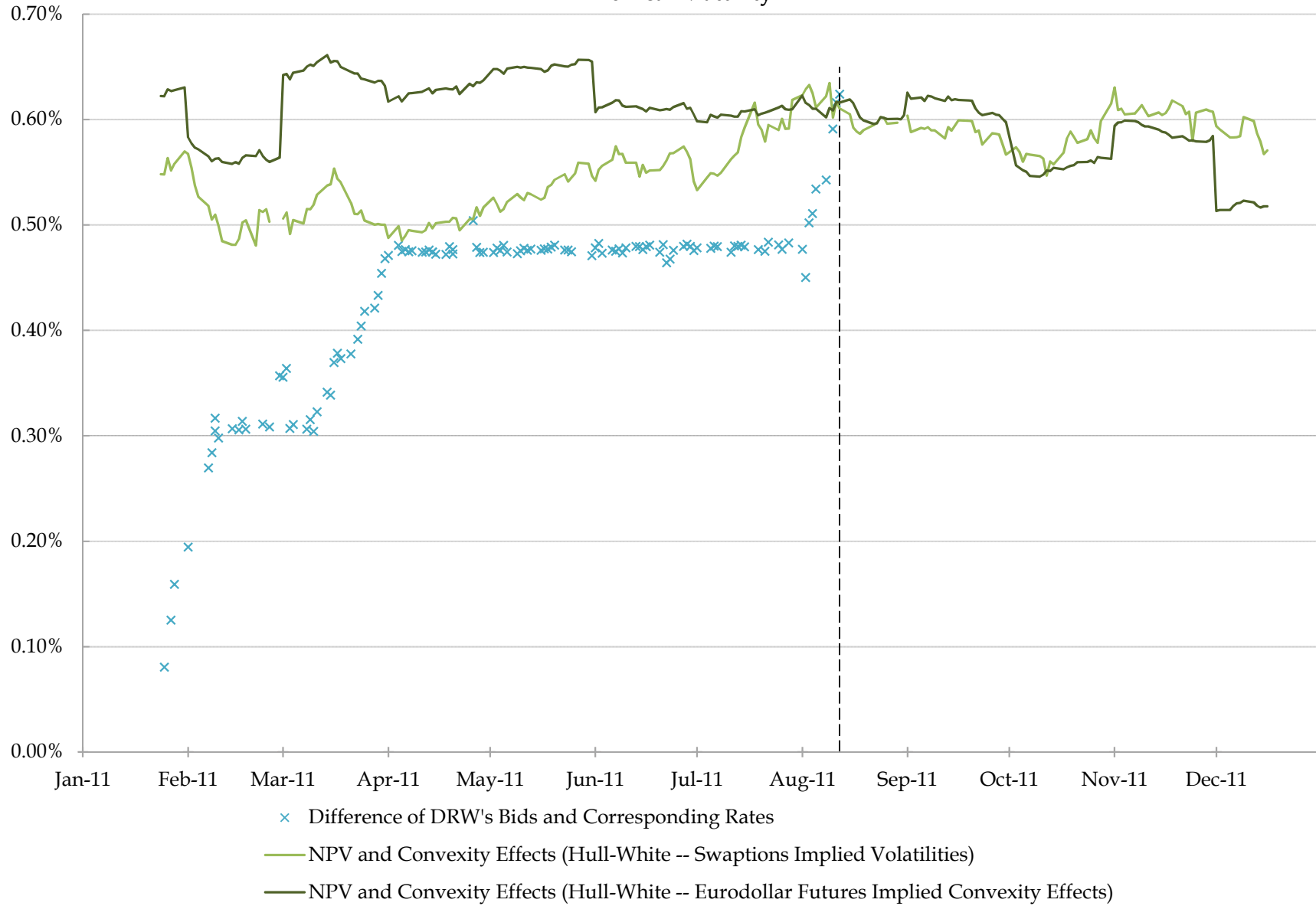


Exhibit 3F
Difference of DRW's Bids and Corresponding Rates and Hull-White NPV and Convexity Effects
25-Year Maturity



Exhibit 3G
Difference of DRW's Bids and Corresponding Rates and Hull-White NPV and Convexity Effects
30-Year Maturity



Exhibit 3

Difference of DRW's Bids and Corresponding Rates and Hull-White NPV and Convexity Effects

Notes:

- [1] Difference of DRW's Bids and Corresponding Rates represents the difference between DRW's Bids and the Corresponding Rates.
- [2] Difference of DRW's Bids and Corresponding Rates reflects only those bids placed by DRW during the PM Settlement Period (1:45-2:00 PM CT).
- [3] Difference of DRW's Bids and Corresponding Rates excludes bids not within 0.20% of the IDEX Curve. A total of 19 bids were excluded across all maturities.
- [4] Corresponding Rates are obtained from IDCG. See DRW-IDCG-0000003.xlsx and Deposition of Garry O'Connor, pp. 211-21, JEF-CFTC472883-85.

Sources:

- [1] Deposition of Garry O'Connor, September 18, 2012, JEF-CFTC-472831-920 and Exhibit 74 to the Deposition of Garry O'Connor, JEF-CFTC-474132.
- [2] DRW-IDCG-0000001.xlsx
- [3] DRW-IDCG-0000003.xlsx
- [4] Brian Vander Luitgaren IDCH Activity Logs Produced by DRW on December 14, 2011 and February 6, 2012.
- [5] Bloomberg, L.P.

Exhibit 4A
Differences of IDEX Curve and Corresponding Rates and Hull-White NPV and Convexity Effects
7-Year Maturity

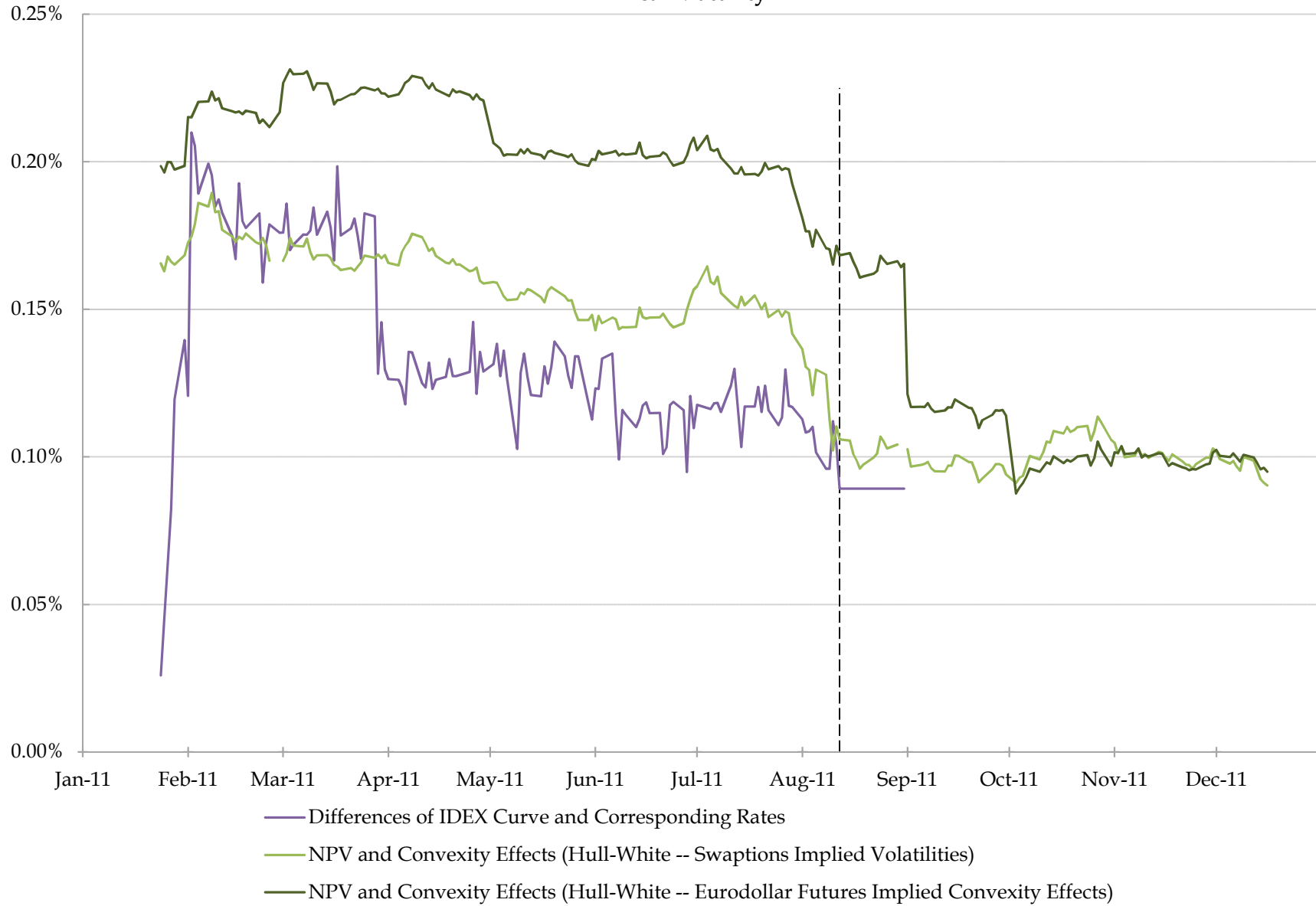


Exhibit 4B
Differences of IDEX Curve and Corresponding Rates and Hull-White NPV and Convexity Effects
10-Year Maturity

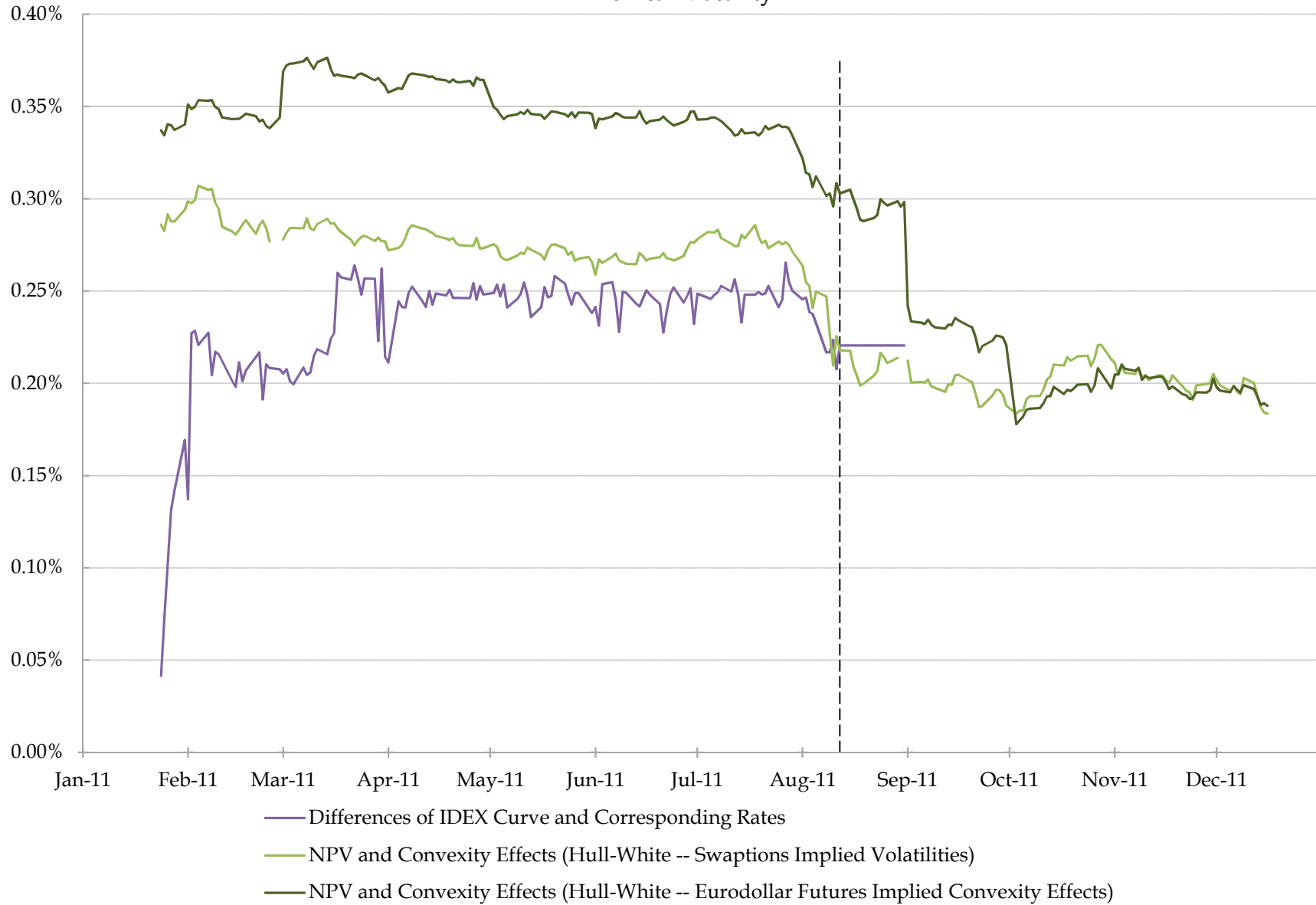


Exhibit 4C
Differences of IDEX Curve and Corresponding Rates and Hull-White NPV and Convexity Effects
12-Year Maturity

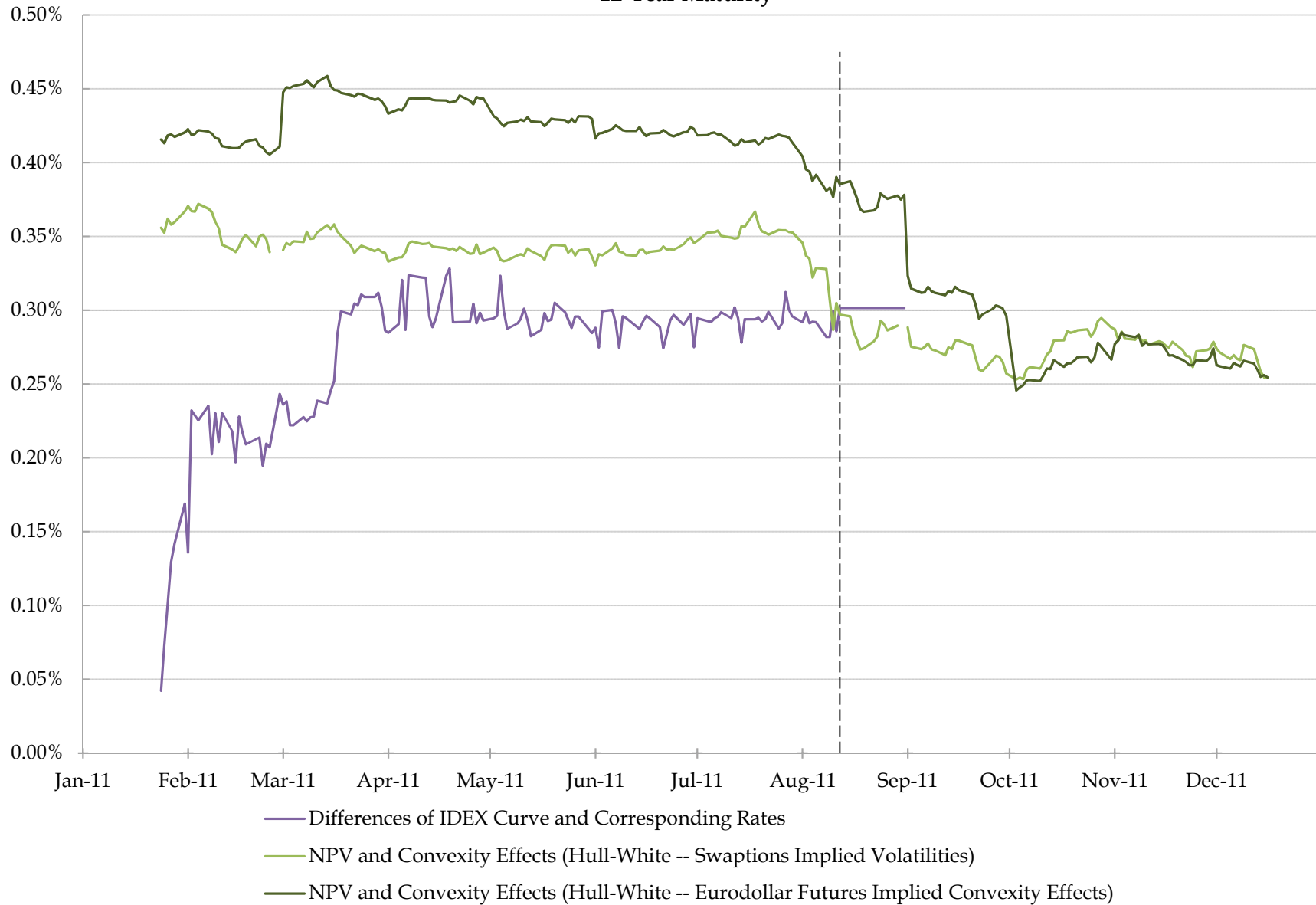


Exhibit 4D
Differences of IDEX Curve and Corresponding Rates and Hull-White NPV and Convexity Effects
15-Year Maturity

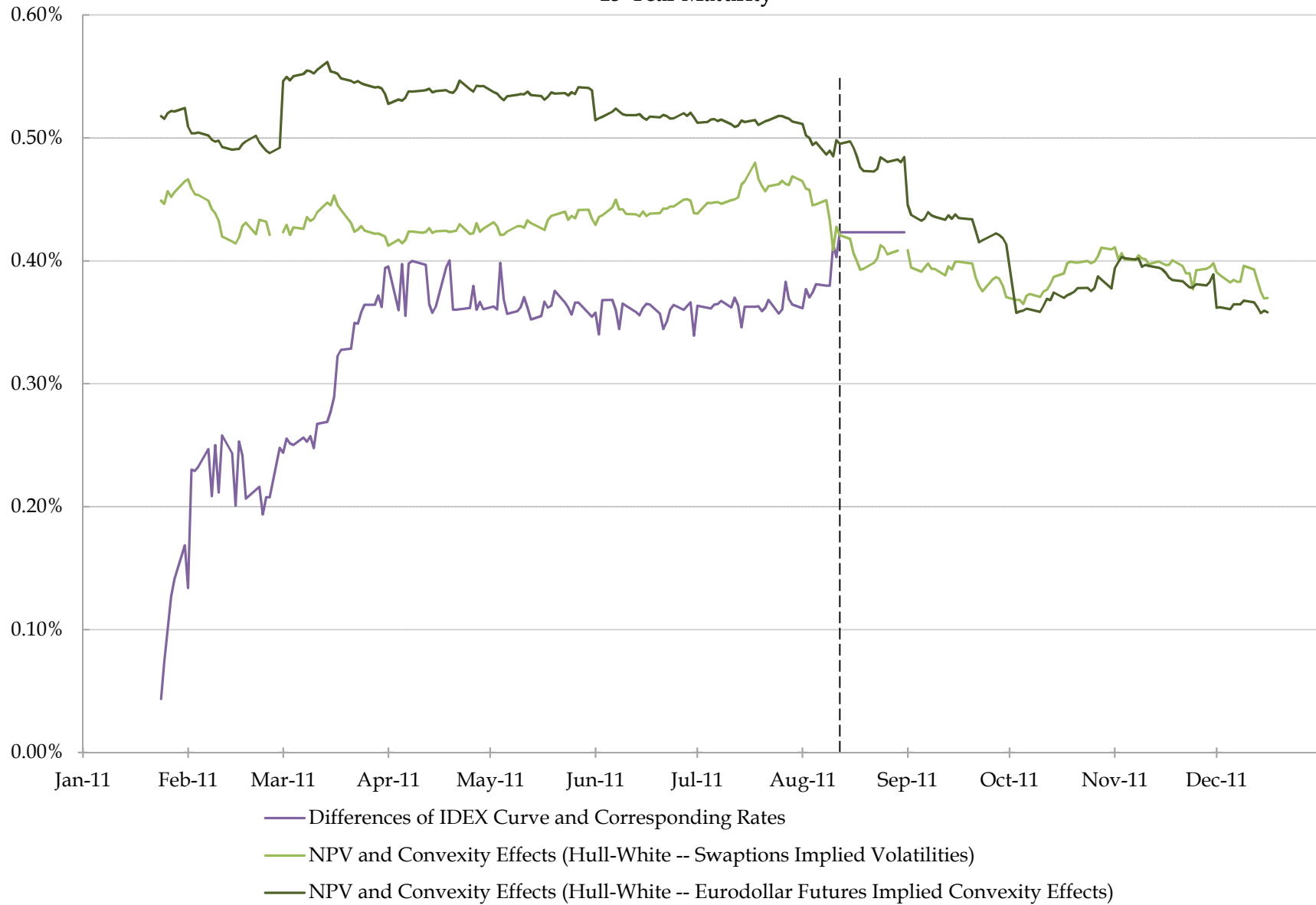


Exhibit 4E
Differences of IDEX Curve and Corresponding Rates and Hull-White NPV and Convexity Effects
20-Year Maturity

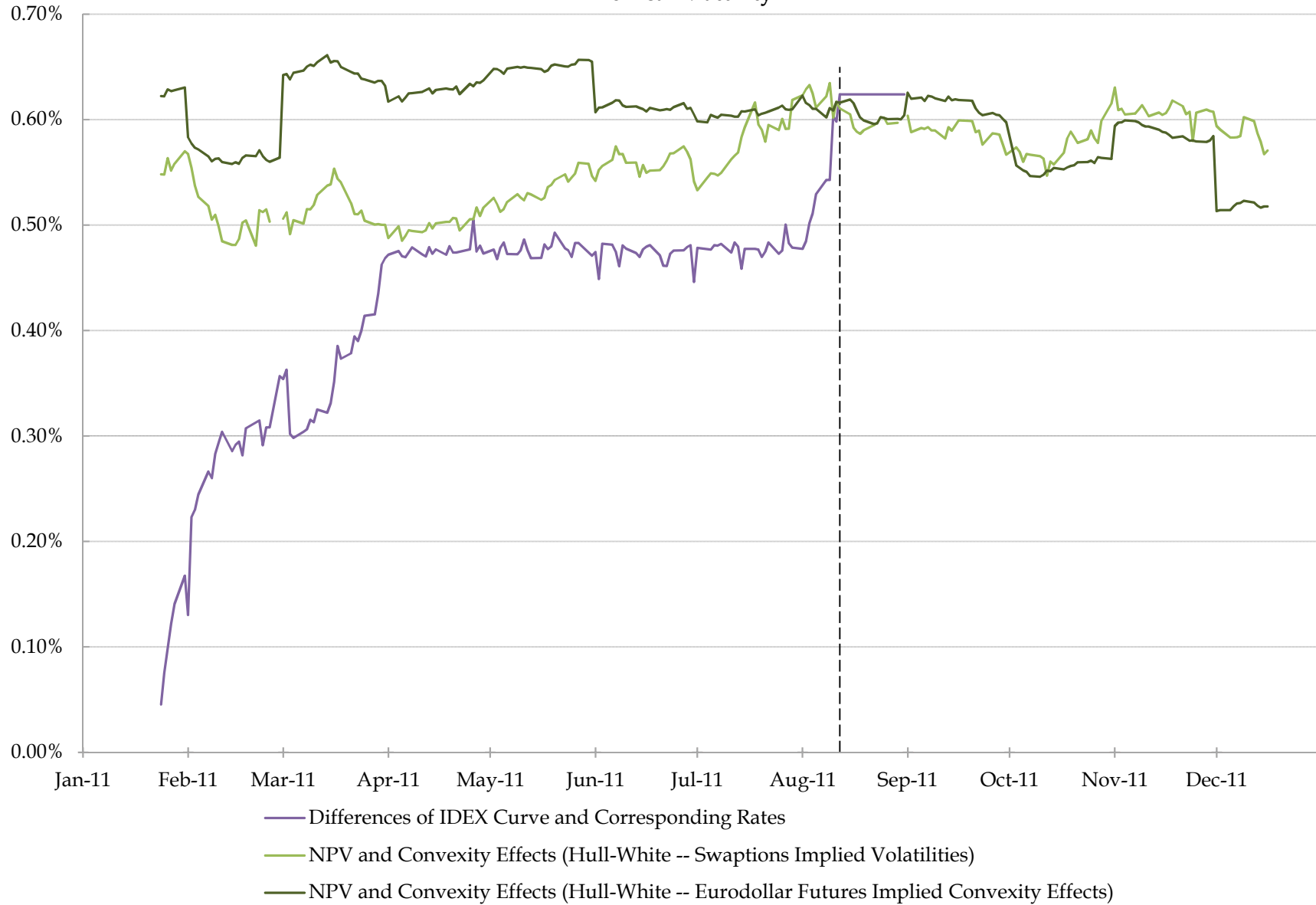


Exhibit 4F
Differences of IDEX Curve and Corresponding Rates and Hull-White NPV and Convexity Effects
25-Year Maturity



Exhibit 4G
Differences of IDEX Curve and Corresponding Rates and Hull-White NPV and Convexity Effects
30-Year Maturity

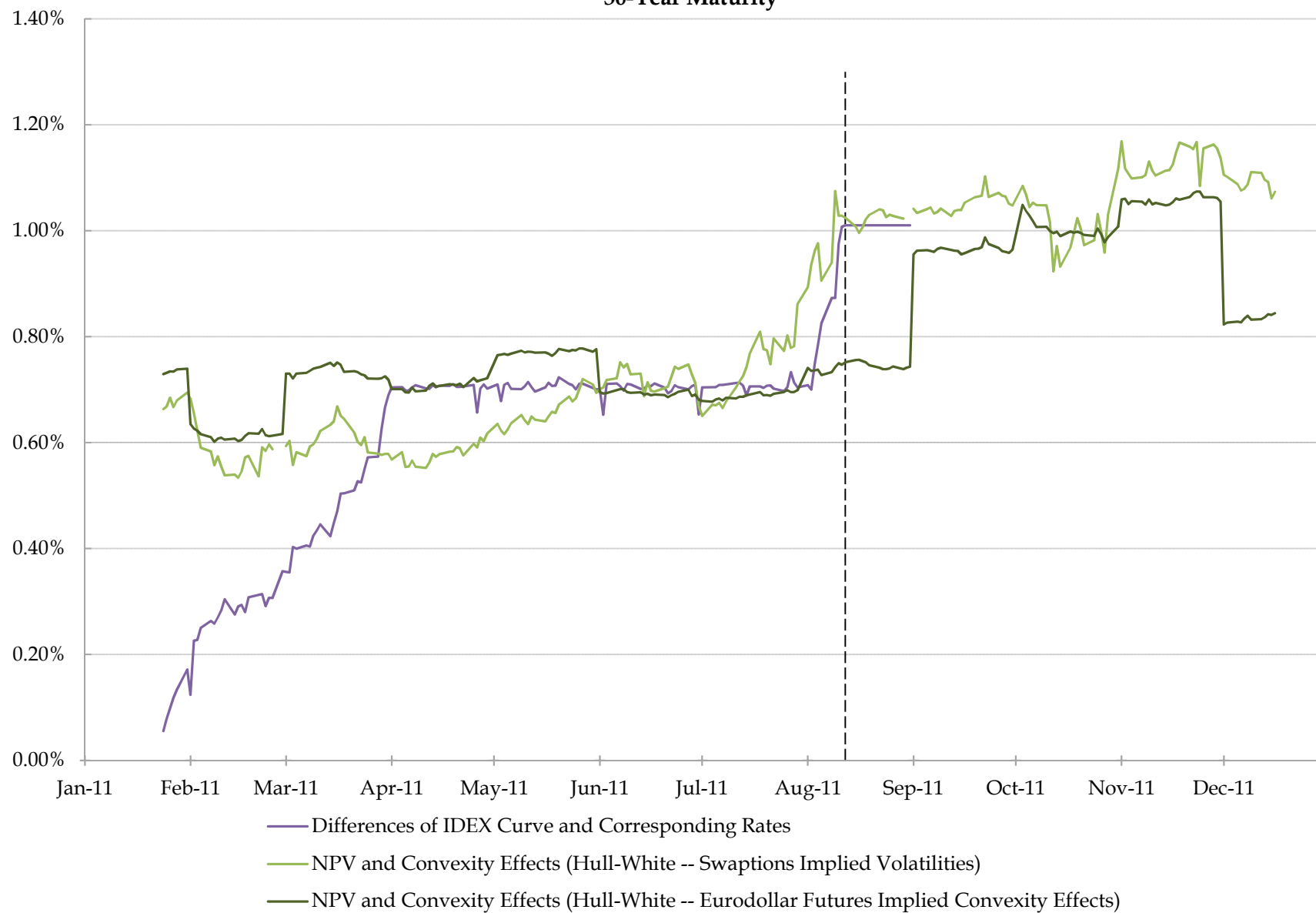


Exhibit 4

Differences of IDEX Curve and Corresponding Rates and Hull-White NPV and Convexity Effects

Notes:

- [1] Differences of IDEX Curve and Corresponding Rates represents the differences between the IDEX Curve and the Corresponding Rates.
- [2] Corresponding Rates are obtained from IDCG. See DRW-IDCG-0000003.xlsx and Deposition of Garry O'Connor, pp. 211-21, JEF-CFTC472883-85.

Sources:

- [1] Deposition of Garry O'Connor, September 18, 2012, JEF-CFTC-472831-920 and Exhibit 74 to the Deposition of Garry O'Connor, JEF-CFTC-474132.
- [2] DRW-IDCG-0000003.xlsx
- [3] Bloomberg, L.P.

Exhibit 5
DRW's Bids on the Three Month Contract
January 24, 2011 - August 12, 2011

Month	Bids Added Between (CT)											Total
	7 - 8 am	8 - 9 am	9 - 9:45 am	9:45 - 10 am	10 - 11 am	11 am - 12 pm	12 - 1 pm	1 - 1:45 pm	1:45 - 2 pm	2 - 3 pm	3 - 4 pm	
January 2011	8	10	7	10	17	16	20	11	37	9	0	145
February 2011	28	48	60	4	41	38	73	84	142	3	3	524
March 2011	32	71	77	47	69	56	46	79	197	0	0	674
April 2011	4	40	28	21	43	49	63	24	180	4	0	456
May 2011	4	12	24	12	20	47	32	37	182	0	1	371
June 2011	0	0	8	4	16	16	36	16	198	0	0	294
July 2011	0	0	8	0	18	4	36	44	148	4	0	262
August 2011	0	0	6	0	8	23	28	22	81	1	0	169
Total	76	181	218	98	232	249	334	317	1,165	21	4	2,895
Percentage of Total	2.6%	6.3%	7.5%	3.4%	8.0%	8.6%	11.5%	10.9%	40.2%	0.7%	0.1%	100.0%

Sources:

[1] DRW-IDCG-0000001.xlsx

[2] Brian Vander Luitgaren IDCH Activity Logs Produced by DRW on December 14, 2011 and February 6, 2012.

Exhibit 6
DRW's Bids on the Three Month Contract
January 24, 2011 - August 12, 2011

Tenor	All of DRW's Bids				DRW's Bids Between 1:45 - 2:00 PM CT			
	Added	Deleted	Matched	Average Time to Deletion	Open	Added	Deleted	Average Time to Deletion
6-Year	1	1	0	0:02:00	1	1	1	0:02:00
7-Year	513	513	0	0:56:07	250	130	113	0:18:02
8-Year	169	169	0	0:23:30	144	127	14	0:18:02
9-Year	172	172	0	0:24:00	144	128	14	0:17:51
10-Year	514	513	1	0:57:14	251	130	113	0:17:46
12-Year	170	170	0	0:23:00	143	129	13	0:17:32
15-Year	168	168	0	0:23:13	142	128	12	0:17:35
20-Year	499	499	0	0:57:41	246	129	108	0:17:54
25-Year	177	177	0	0:21:40	142	129	11	0:17:28
30-Year	512	512	0	0:56:55	253	134	115	0:16:53
Total	2,895	2,894	1	0:46:56	1,716	1,165	514	0:17:39

Notes:

- [1] DRW's Open Bids Between 1:45 - 2:00 PM CT include DRW's bids added between 1:45 - 2:00 PM CT and DRW's bids added prior to 1:45 PM CT that were not deleted or matched as of 1:45 PM CT.
- [2] None of DRW's bids open between 1:45 - 2:00 PM CT were matched.
- [3] Average Time to Deletion for DRW's Bids Between 1:45 - 2:00 PM CT reports the average time to deletion of bids added between 1:45 and 2:00 PM CT.

Sources:

- [1] DRW-IDCG-0000001.xlsx
- [2] Brian Vander Luitgaren IDCH Activity Logs Produced by DRW on December 14, 2011 and February 6, 2012.

Exhibit 7A
DRW's Bids and Corresponding Rates
7-Year Maturity

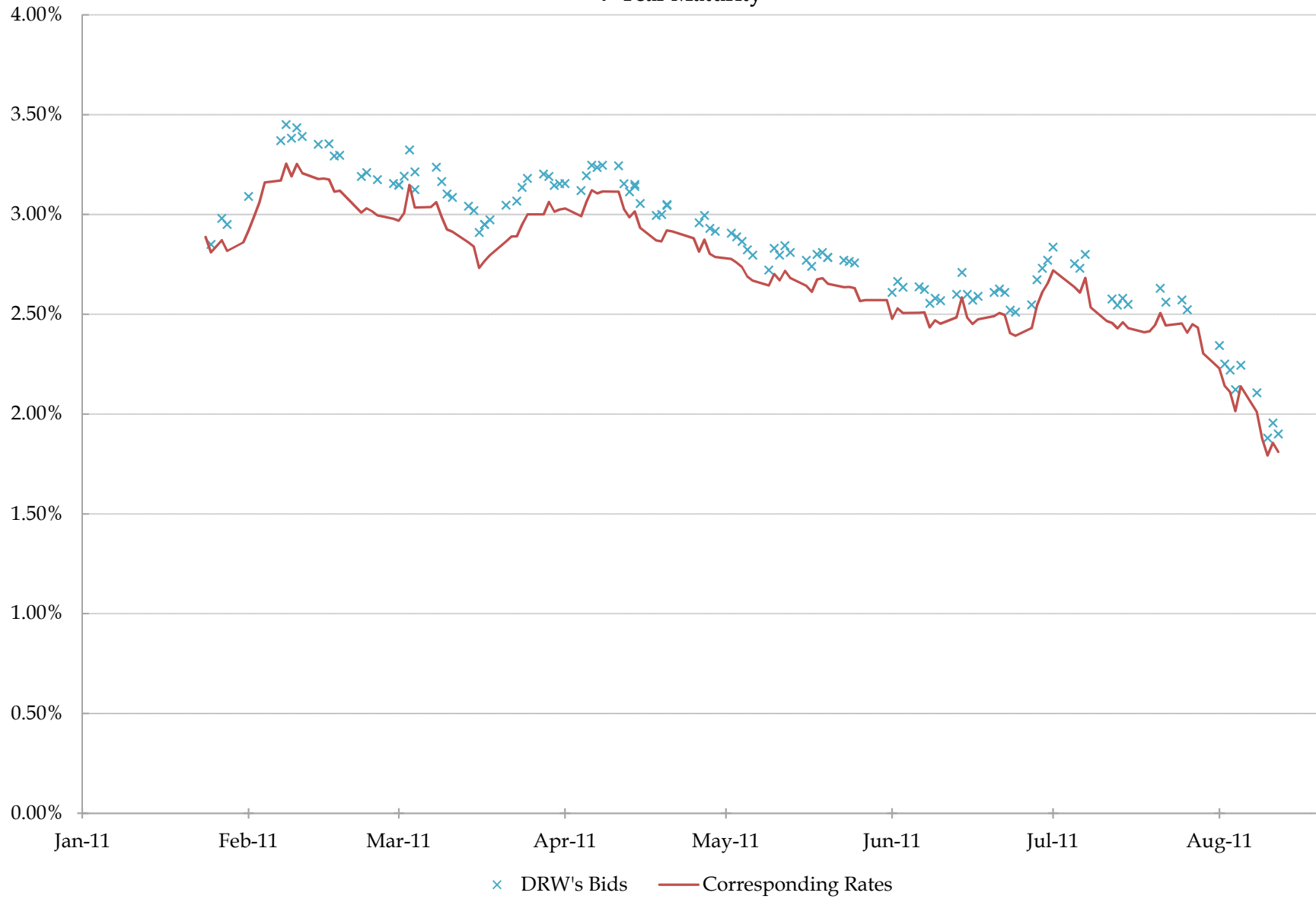


Exhibit 7B
DRW's Bids and Corresponding Rates
10-Year Maturity

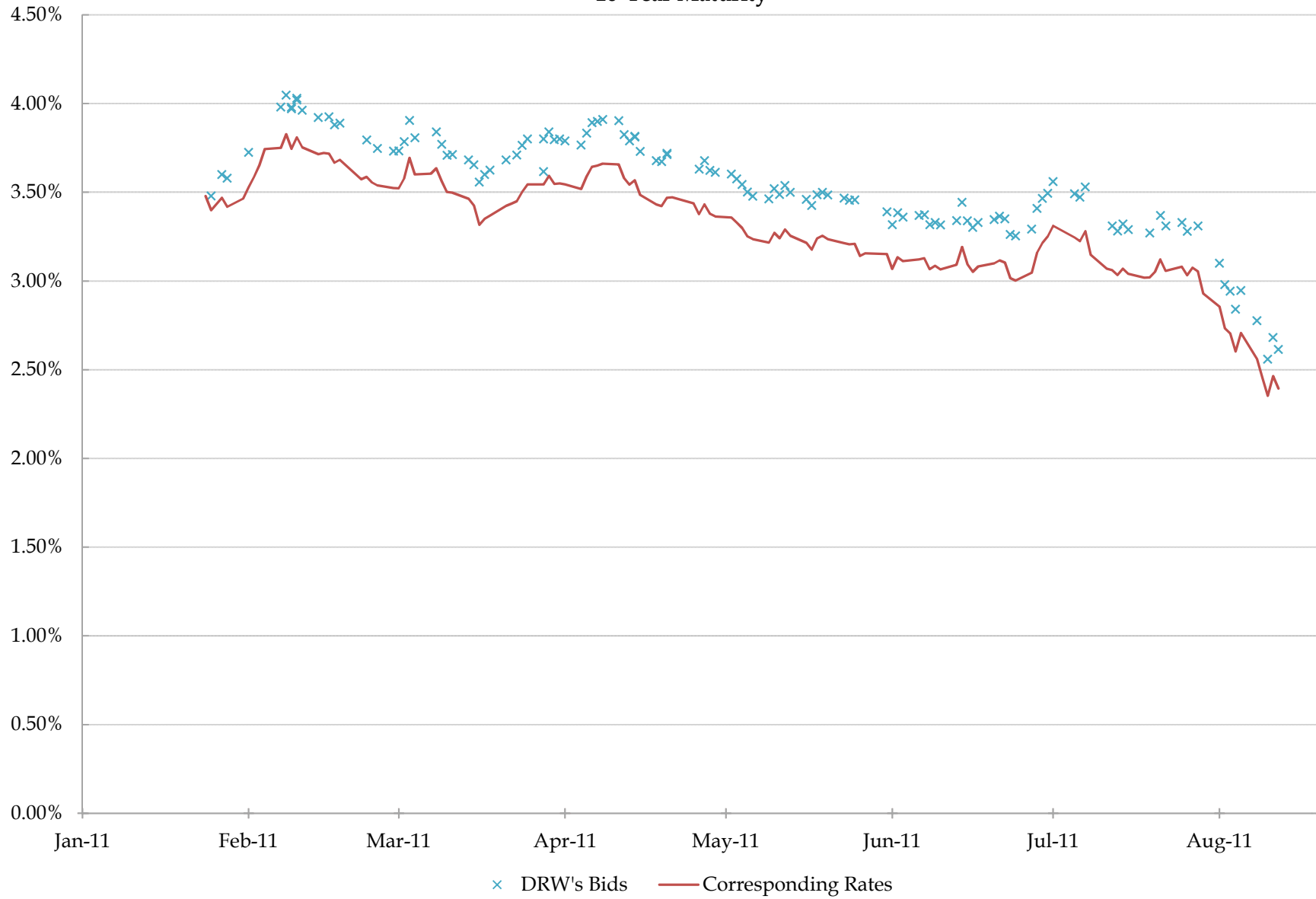


Exhibit 7C
DRW's Bids and Corresponding Rates
12-Year Maturity

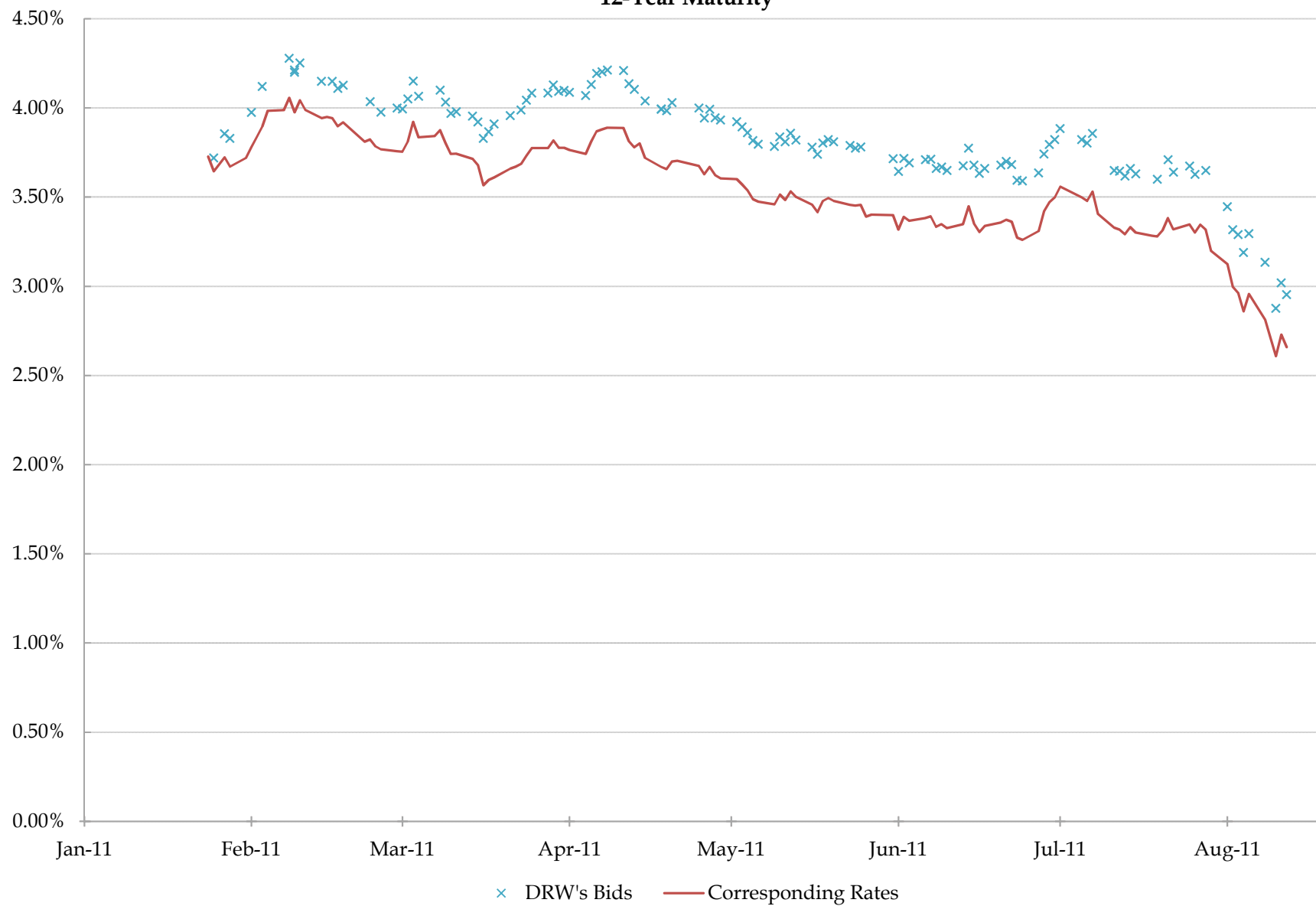


Exhibit 7D
DRW's Bids and Corresponding Rates
15-Year Maturity

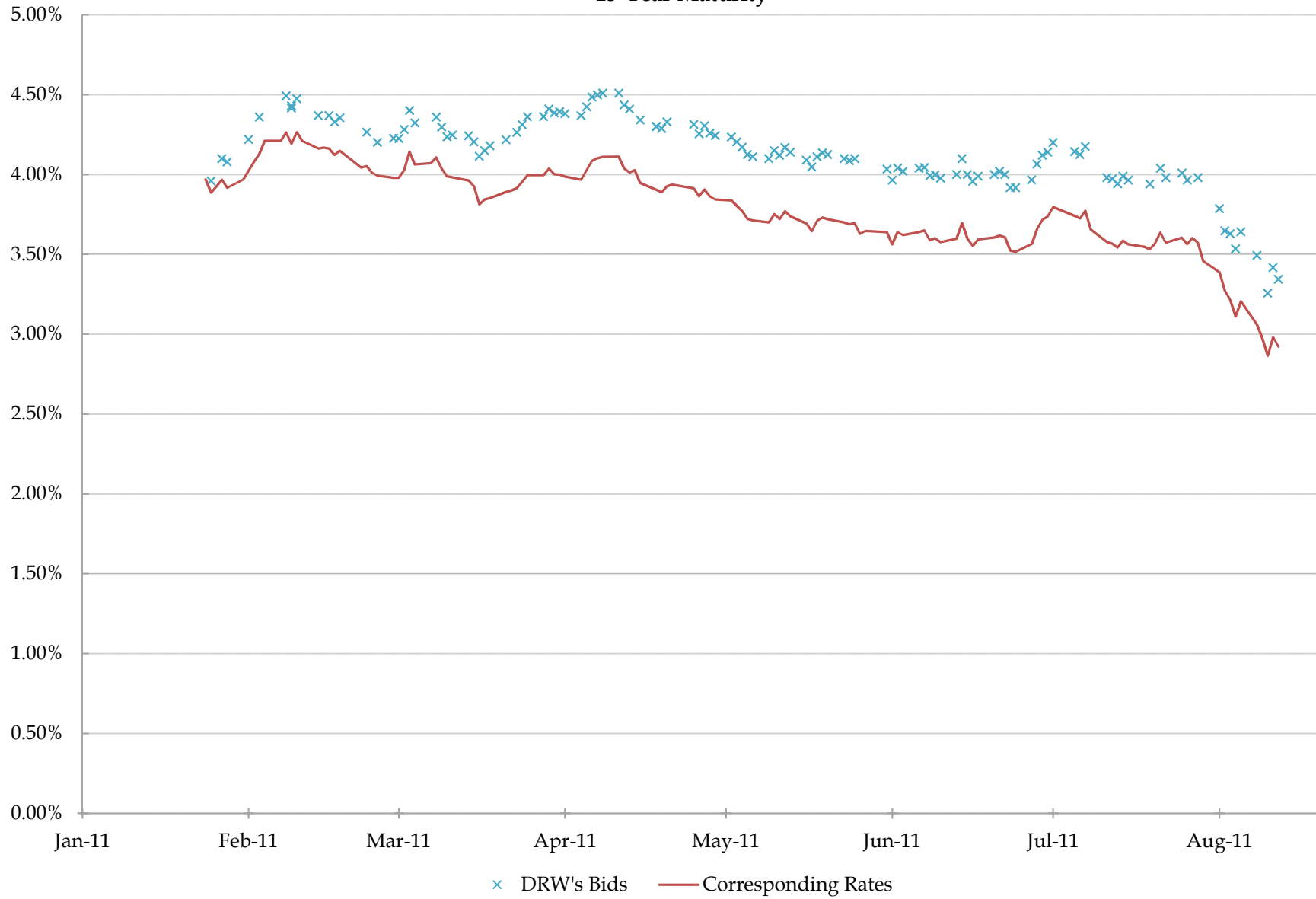


Exhibit 7E
DRW's Bids and Corresponding Rates
20-Year Maturity

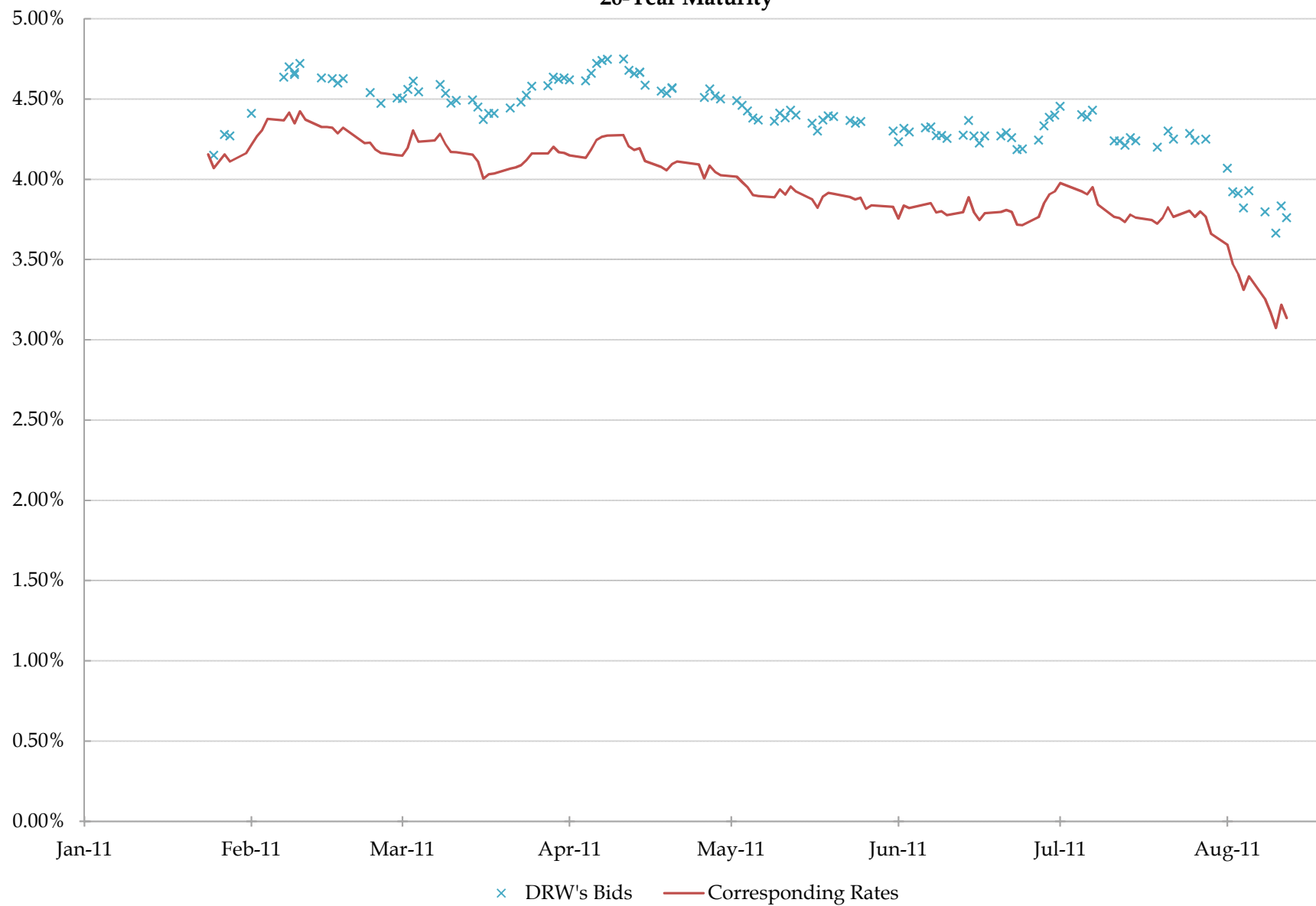


Exhibit 7F
DRW's Bids and Corresponding Rates
25-Year Maturity

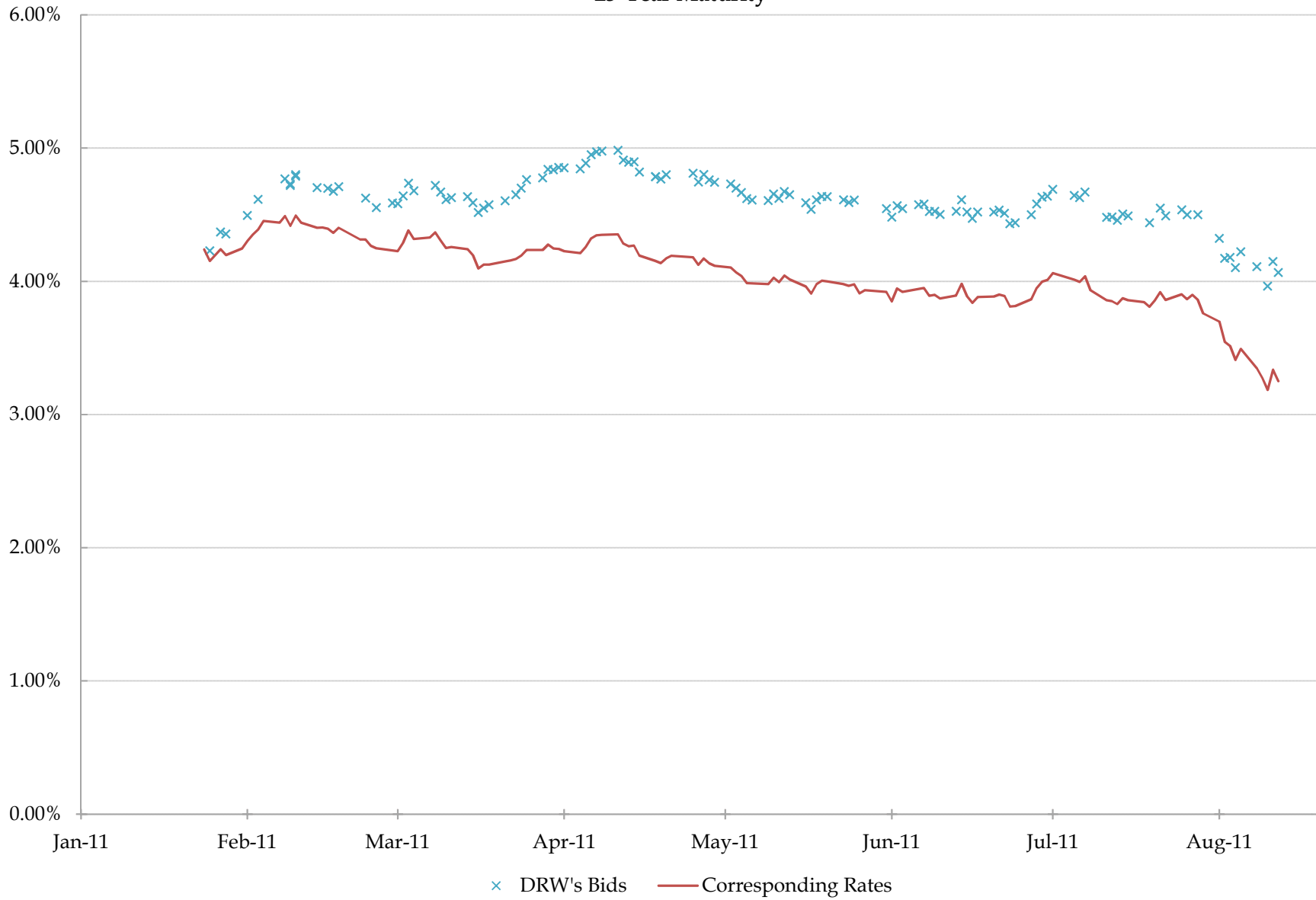


Exhibit 7G
DRW's Bids and Corresponding Rates
30-Year Maturity

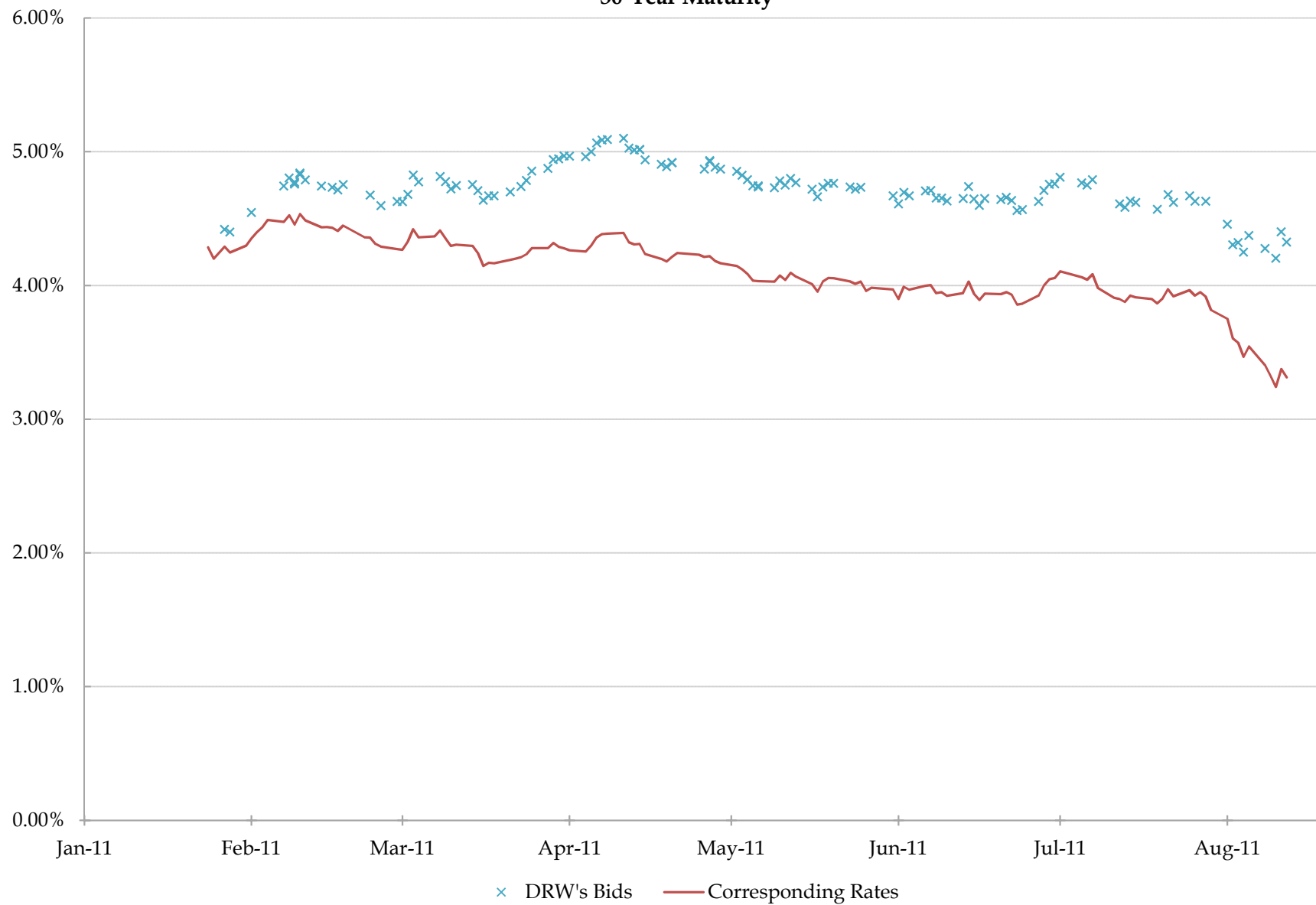


Exhibit 7
DRW's Bids and Corresponding Rates

Notes:

- [1] DRW's Bids reflects only those bids placed by DRW during the PM Settlement Period (1:45-2:00 PM CT).
- [2] DRW's Bids excludes bids not within 0.20% of the IDEX Curve. A total of 19 bids were excluded across all maturities.
- [3] Corresponding Rates are obtained from IDCG. See DRW-IDCG-0000003.xlsx and Deposition of Garry O'Connor, pp. 211-21, JEF-CFTC472883-85.

Sources:

- [1] Deposition of Garry O'Connor, September 18, 2012, JEF-CFTC-472831-920 and Exhibit 74 to the Deposition of Garry O'Connor, JEF-CFTC-474132.
- [2] DRW-IDCG-0000001.xlsx
- [3] DRW-IDCG-0000003.xlsx
- [4] Brian Vander Luitgaren IDCH Activity Logs Produced by DRW on December 14, 2011 and February 6, 2012.

Exhibit 8A
IDEX Curve and Corresponding Rates
7-Year Maturity

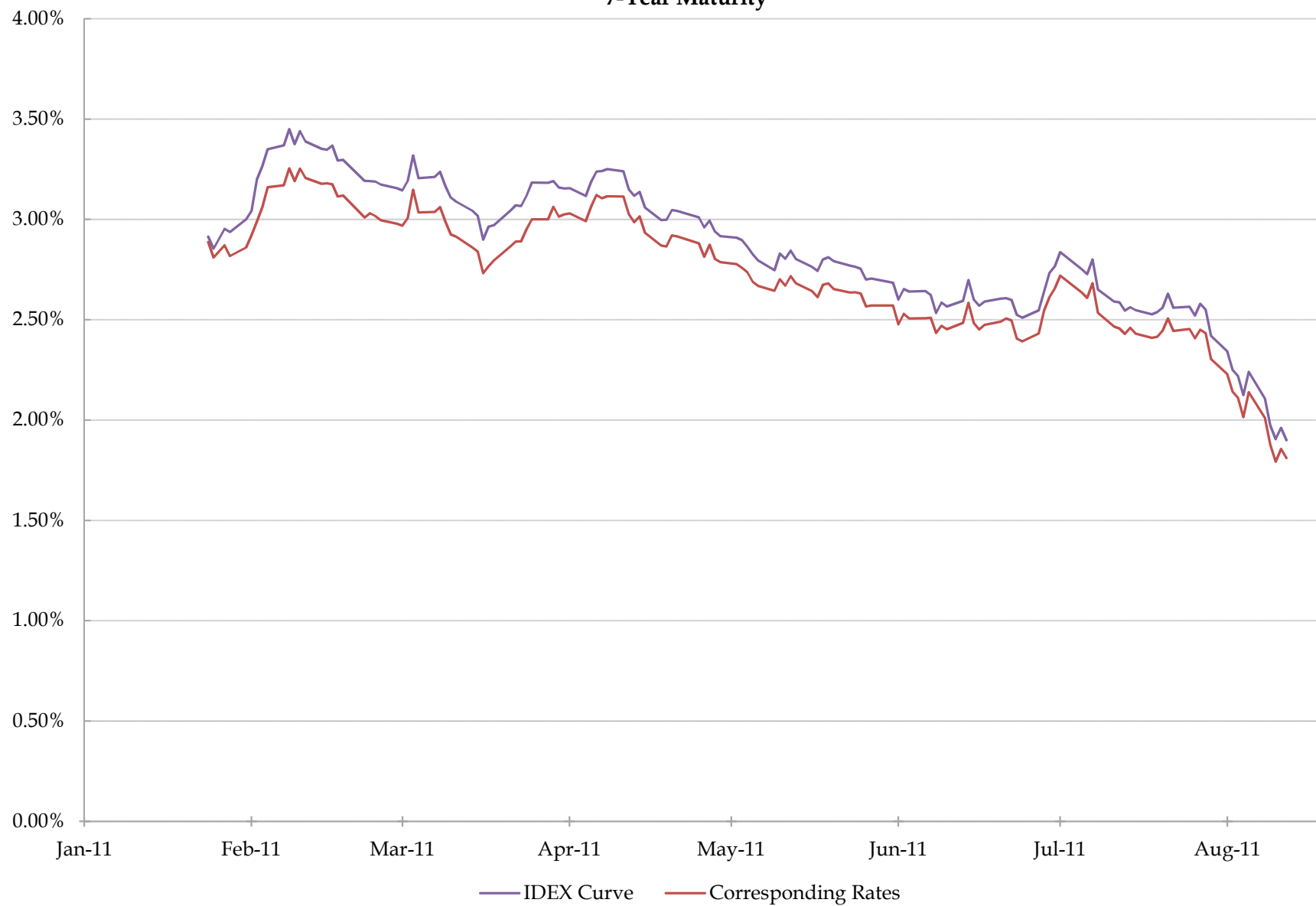


Exhibit 8B
IDEX Curve and Corresponding Rates
10-Year Maturity

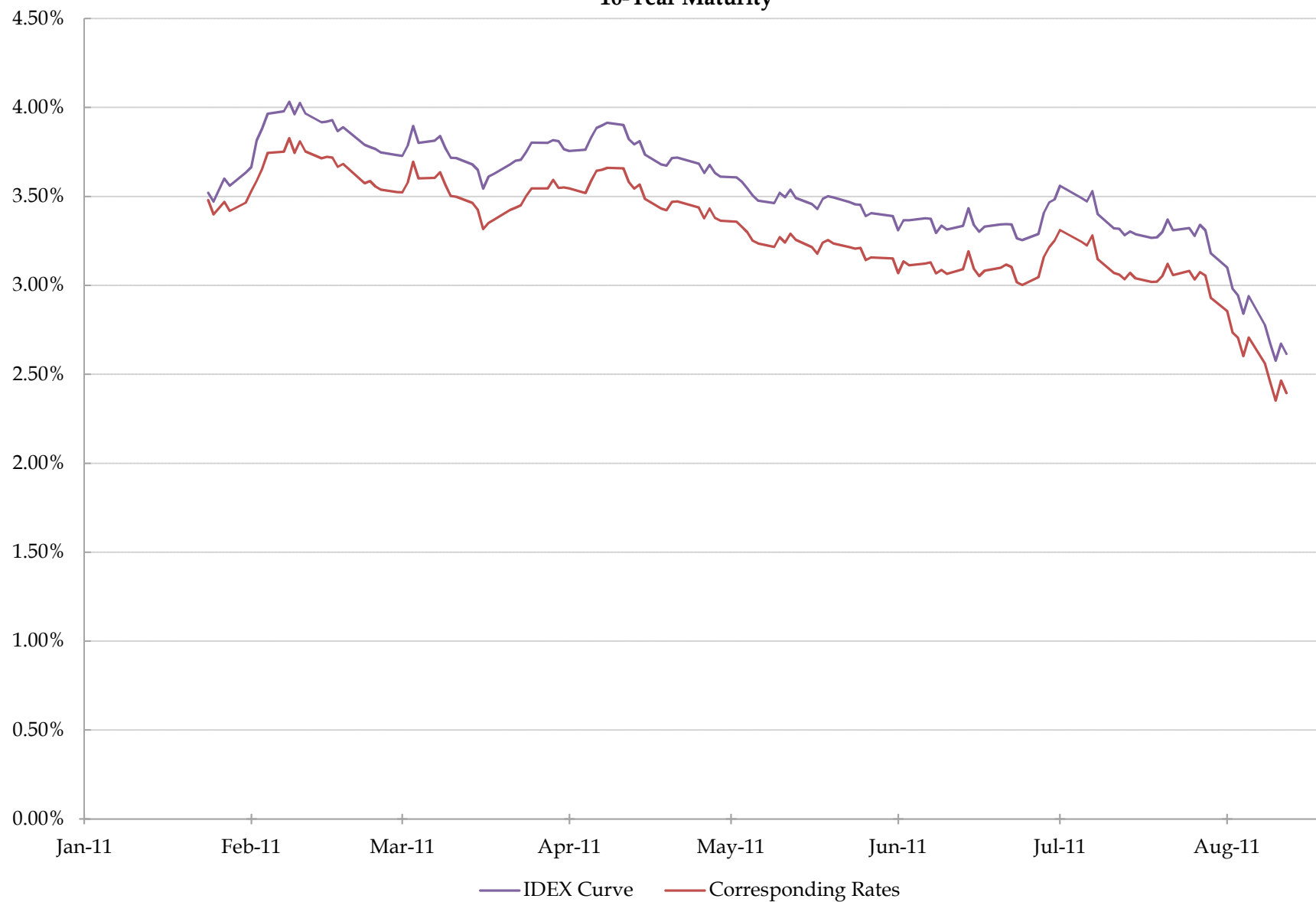


Exhibit 8C
IDEX Curve and Corresponding Rates
12-Year Maturity

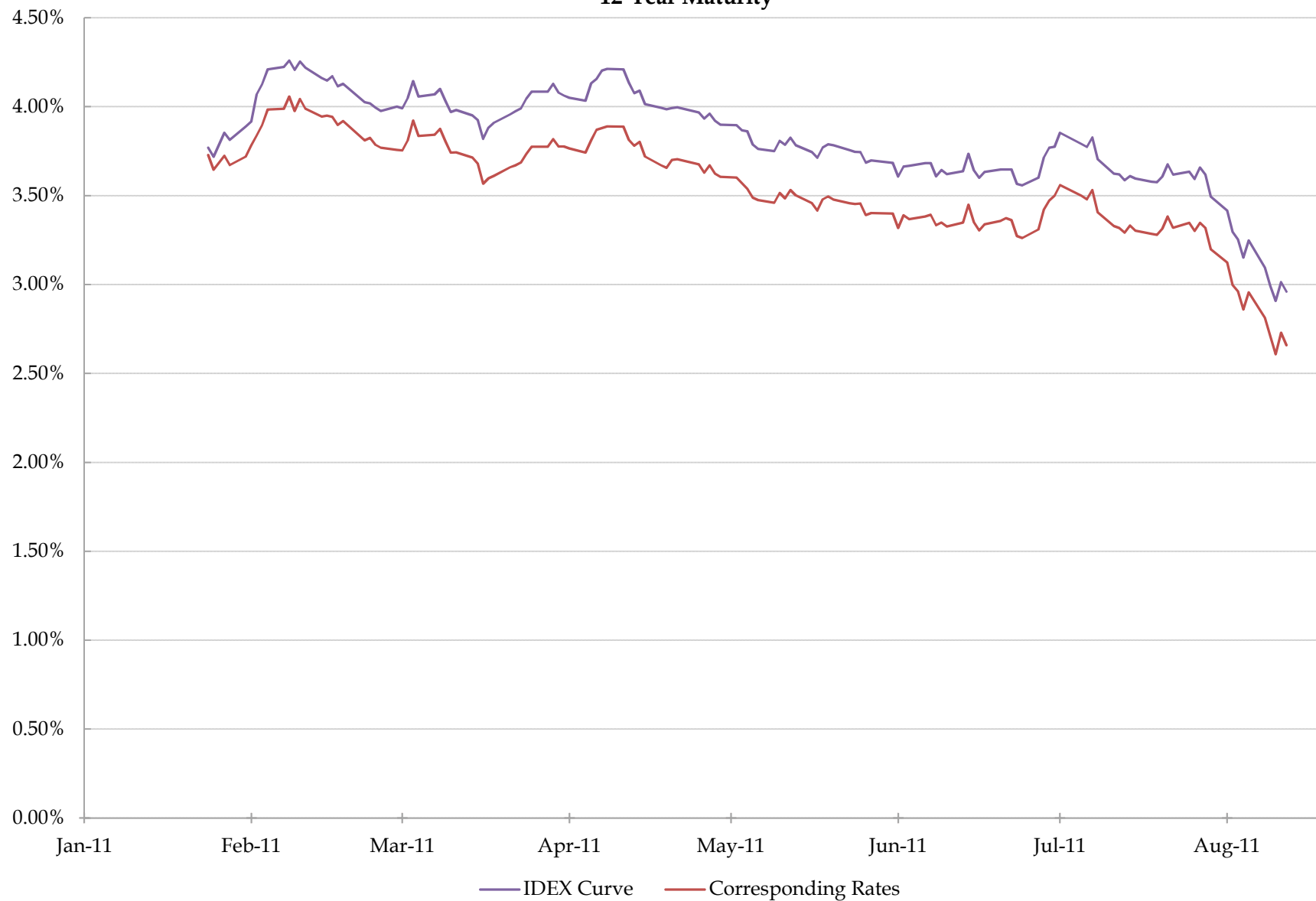


Exhibit 8D
IDEX Curve and Corresponding Rates
15-Year Maturity

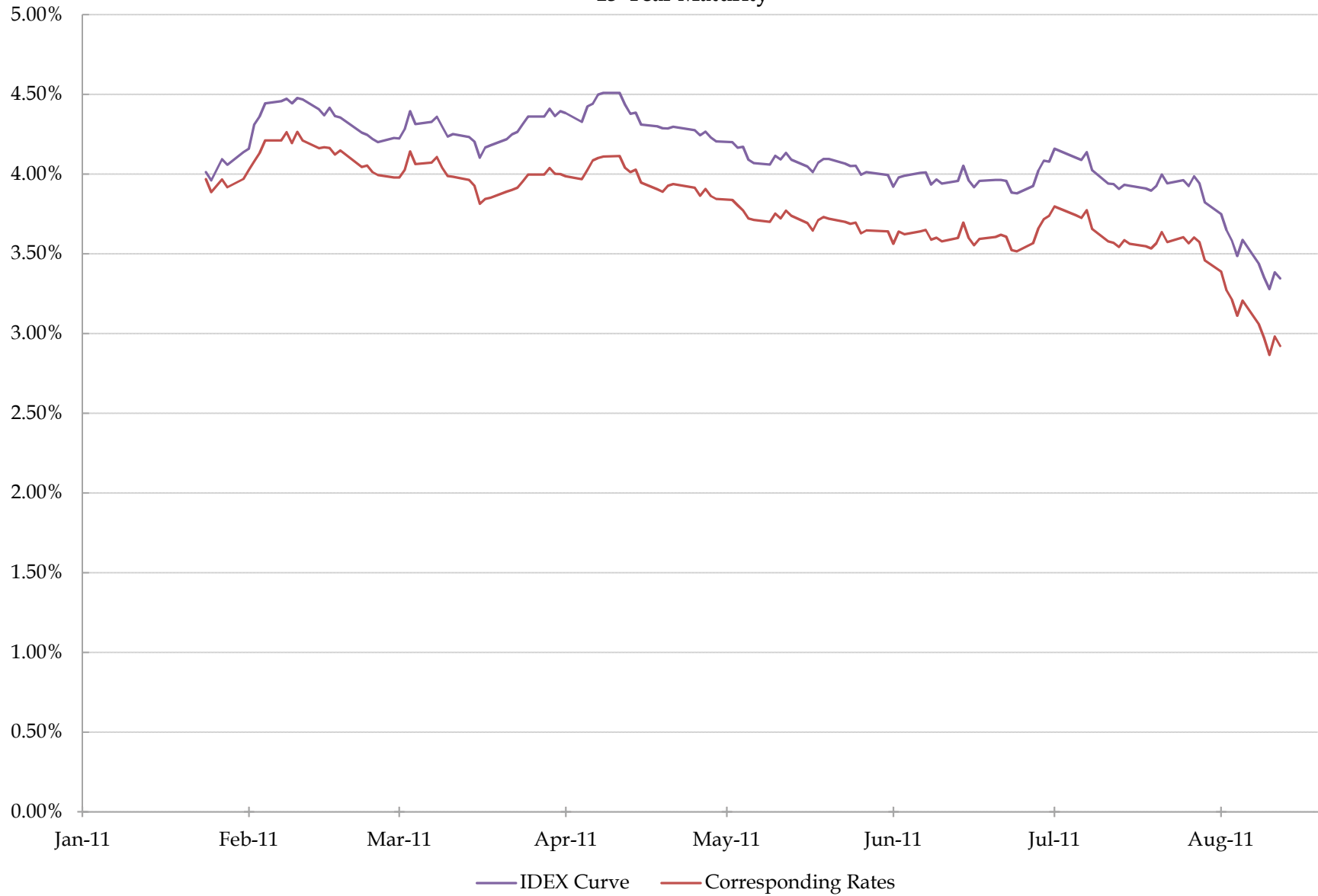


Exhibit 8E
IDEX Curve and Corresponding Rates
20-Year Maturity

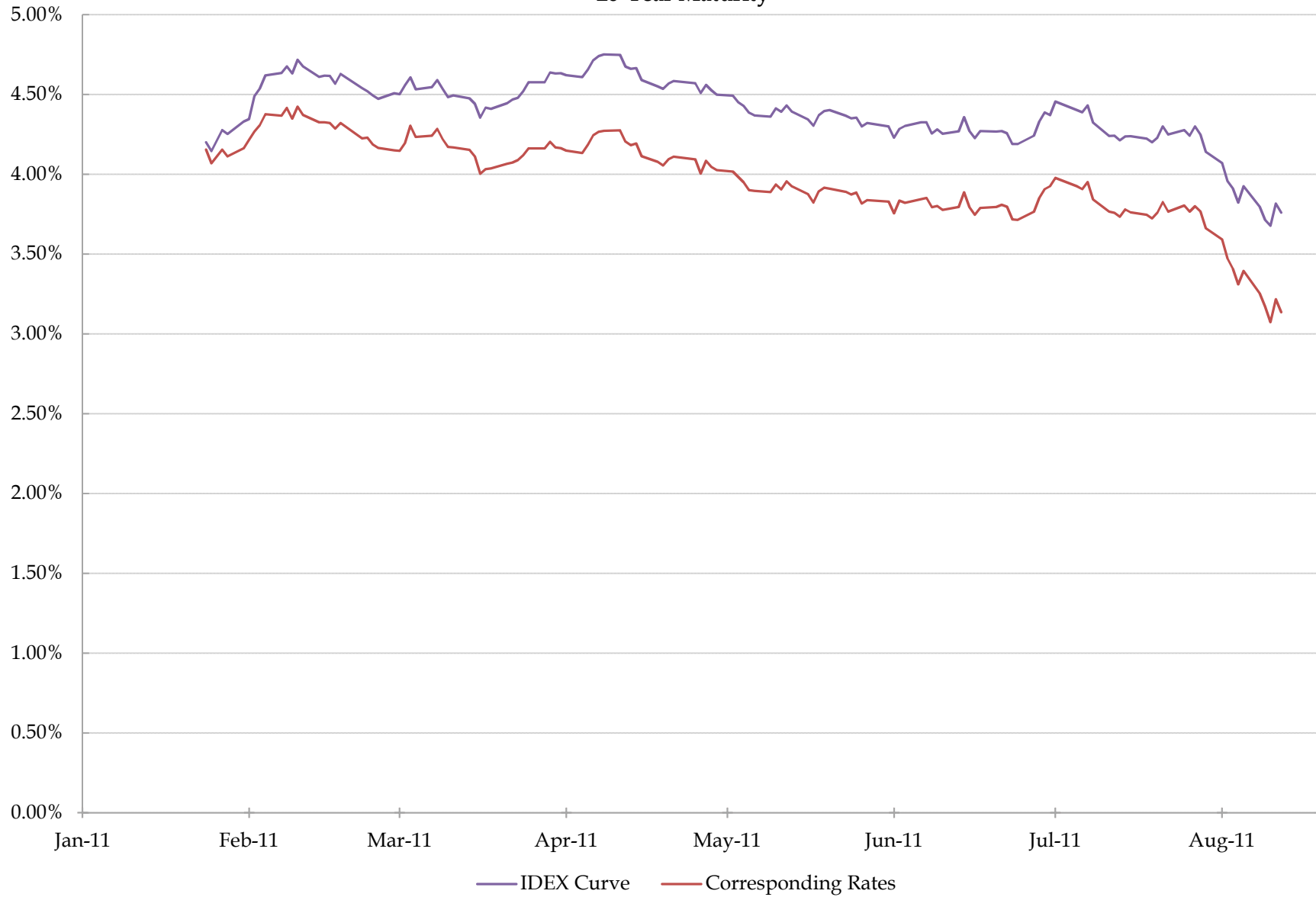


Exhibit 8F
IDEX Curve and Corresponding Rates
25-Year Maturity

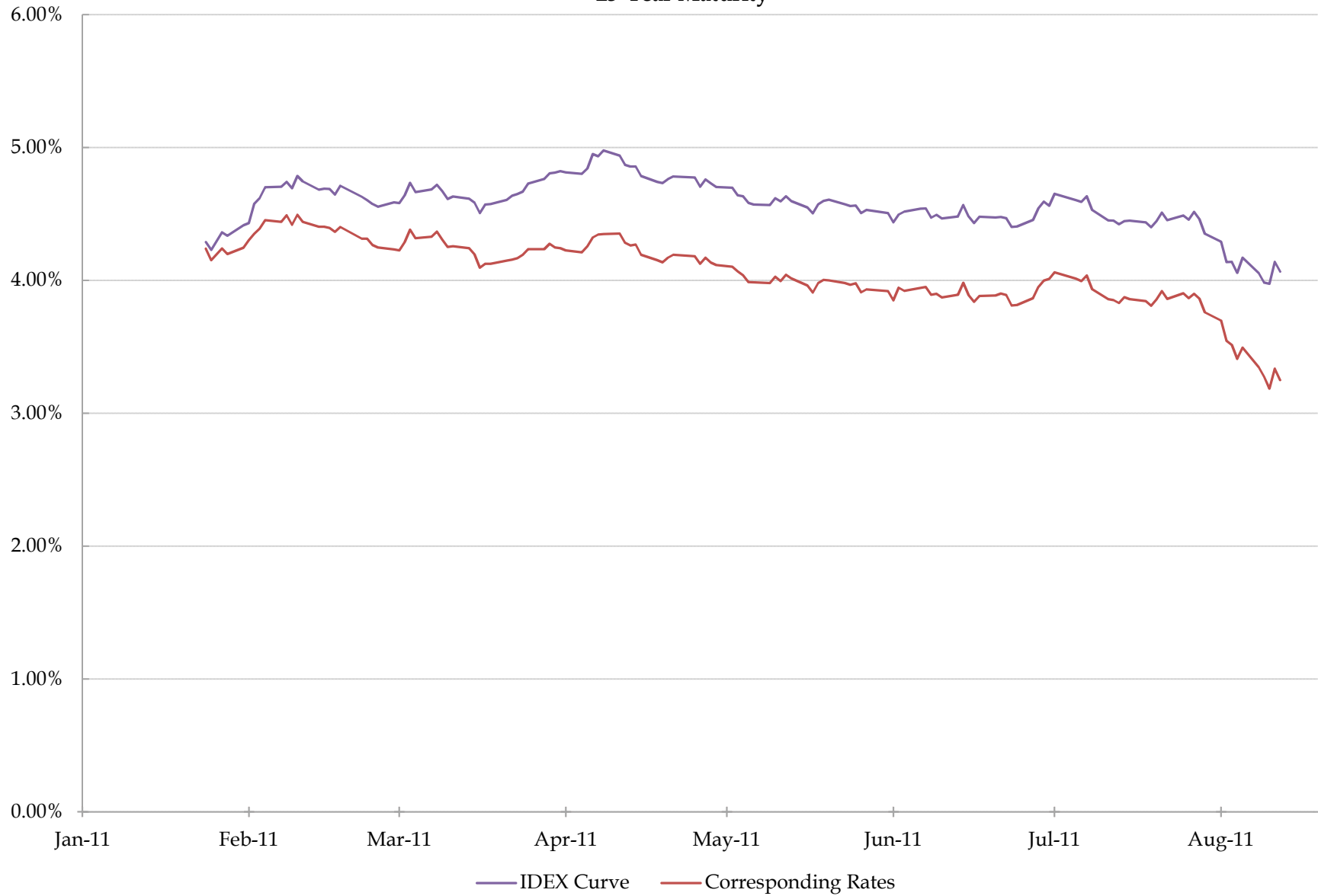


Exhibit 8G
IDEX Curve and Corresponding Rates
30-Year Maturity

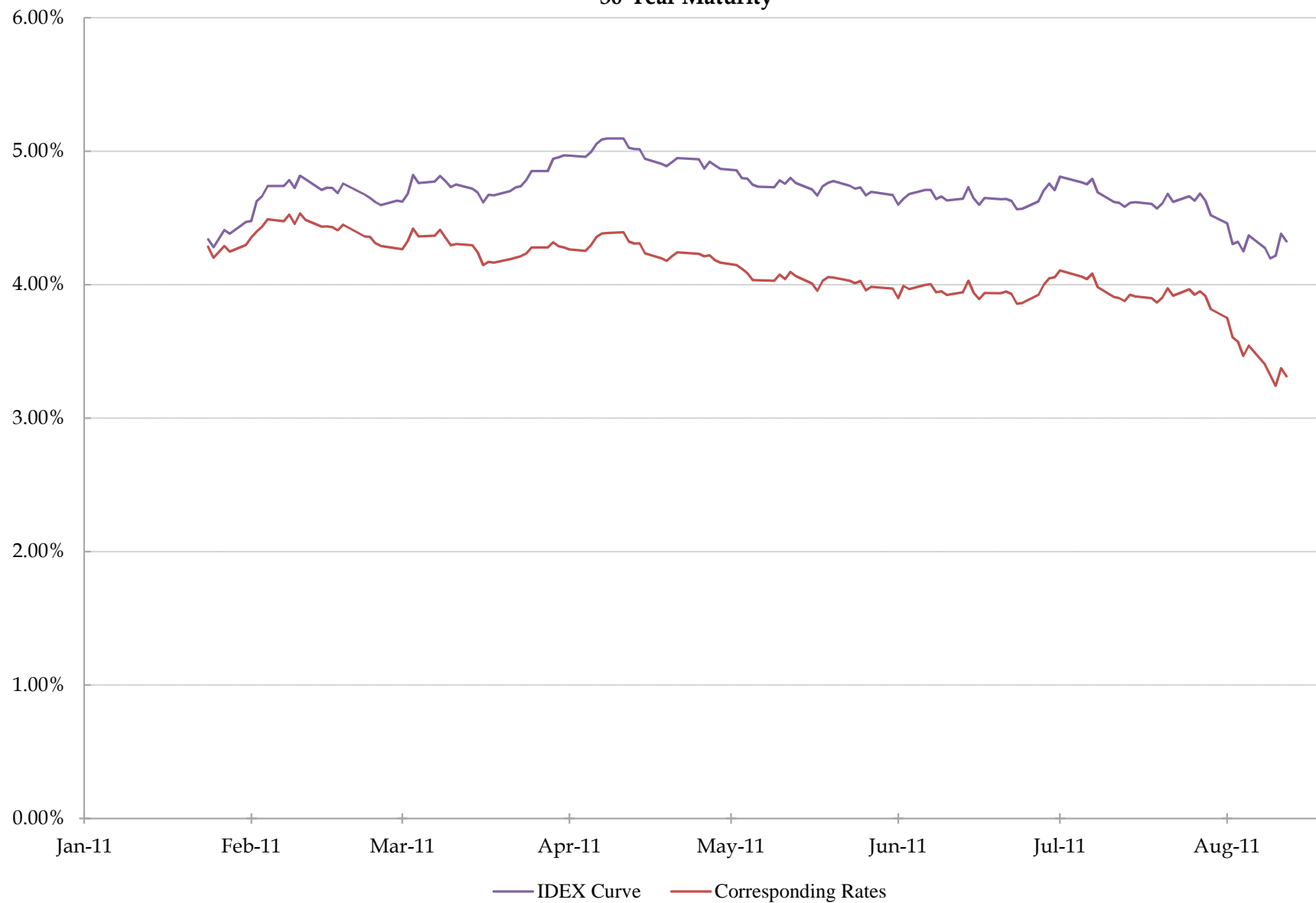


Exhibit 8
IDEX Curve and Corresponding Rates

Note:

[1] Corresponding Rates are obtained from IDCG. See DRW-IDCG-0000003.xlsx and Deposition of Garry O'Connor, pp. 211-21, JEF-CFTC472883-85.

Sources:

[1] Deposition of Garry O'Connor, September 18, 2012, JEF-CFTC-472831-920 and Exhibit 74 to the Deposition of Garry O'Connor, JEF-CFTC-474132.

[2] DRW-IDCG-0000003.xlsx

Appendix A

Curriculum Vitae of Jeffrey H. Harris

205 Kogod
American University
Washington, DC 20016
(202) 885-6669
jharris@american.edu

Education

Ph.D., Business Administration, Finance. The Ohio State University, 1995

M.B.A., Finance. The University of Iowa, 1987

B.A., Physics. Economics Minor. The University of Iowa, 1986
Attended Luther College, 1982-84

Employment History

American University, Gary Cohn Goldman Sachs Chair in Finance, 2013-Present
Finance and Real Estate Department Chair, 2014-Present

Syracuse University, Dean's Chair in Finance, 2011-2013

University of Delaware, Professor, 2006-11
Associate Professor, 2003-06
Assistant Professor, 2001-03

Southern Methodist University, James M. Collins Chair (Visiting), 2010-11

U.S. Commodity Futures Trading Commission, Chief Economist, 2007-10
Visiting Academic/Consultant, 2006-07

University of Notre Dame, Assistant Professor, 1995-2001

Nasdaq Department of Economic Research, Visiting Academic Fellow, 2000-01

U.S. Securities and Exchange Commission, Visiting Academic Scholar, 1999-2000

The Ohio State University, Visiting Assistant Professor, 1995-97

Professional Activities

Testimony before Congress

“The Role of Speculative Investments in Energy Markets” before the United States Senate Subcommittee on Energy and Natural Resources, September 16, 2008.

“Financial Speculation in Commodity Markets: Are Institutional Investors and Hedge Funds Contributing to Food and Energy Price Inflation?” before the United States Senate Committee on Homeland Security and Governmental Affairs, May 20, 2008.

“The Influence of Speculative Traders in Commodity Markets” before the United States House of Representatives Agriculture Committee, May 15, 2008.

“The Influence of Non-commercial Institutional Investors on Oil Prices” before the United States Senate Committee on Energy and Natural Resources, April 3, 2008.

Testimony before the Commodity Futures Trading Commission

“Price Discovery in Natural Gas Markets” before the United States Commodity Futures Trading Commission Hearing to Examine Trading on Regulated Exchanges and Exempt Commercial Markets, September 18, 2007.

“Price Convergence in Agricultural Markets” before the United States Commodity Futures Trading Commission Agricultural Markets Roundtable, April 22, 2008.

“On Position Limits” before the United States Commodity Futures Trading Commission Open Meeting Regarding Proposed Position Limits Rule, January 14, 2010.

Expert Reports

In re: United States Securities and Exchange Commission v. Moises Saba Masri and Albert Meyer Sutton

In re: Sycamore Networks, Inc. Initial Public Offering Securities Litigation

In re: United States v. Sergey Aleynikov

In re: United States v. George Holley

In re: Qimonda Richmond, LLC, et al. Debtors, Chapter 11

In re: U.S. Commodity Futures Trading Commission v. Donald A. Newell and

Quiddity, LLC

Keynote Address,

"Index Trading and Speculation in Commodity Futures Markets" at the 2011 InVivo Paris

Conference on Speculation in Agriculture Markets.

"Energy Markets and Dodd-Frank: Where are we now?" at the 2012 Fulbright Jaworski/Cornerstone Research conference on Dodd-Frank's Impact on the

Energy Markets.

"Financial Trading, Energy Markets and Dodd-Frank" at the 2012 Oklahoma State MSQFE Alumni Weekend.

Panelist,

"Current Events in Commodity Markets" panel at the CME Group 2nd Annual Global Commodity Investment Roundtable, New York 2013.

"Financial Trading, Derivative Markets and Commodities" presentation on "Interaction between Physical and Financial Commodity Markets – A Role for Regulators" panel at the Luxembourg IOSCO Member Meetings, Luxembourg 2013.

"Commodity Market Regulation: Achieving Transparency while Maintaining Liquidity" panel at the Global Grain Conference, Chicago 2013.

"Dodd-Frank and Commodity Markets" panel at the Terrapinn World Commodities Week, London 2011.

"Oil Prices--Rising Prices, Speculation and Regulation" panel at the Standard Chartered Bank Hong Kong Earth Resource Conference, 2011.

"The Regulatory World of Market Manipulation" panel at the American Bar Association Antitrust and Consumer Law Issues in the Energy Industry Conference, Houston 2011.

"Commodity Super-cycles" panel at Standard Chartered Bank New York Symposium, New York 2011.

"Assessing Dodd-Frank" panel on current financial regulation, National Association of Business Economists, Washington, DC 2010.

"What's Next?" panel on post-crisis regulation, Georgetown University, 2010.

"Sovereign CDS Markets" discussion panel at Georgetown University, 2010

"IPOs and the JOBS Act" panel at the U.S. Securities and Exchange Commission,.

Publications

"Speculation, Prices and Market Volatility" with Celso Brunetti and Bahattin Büyüksahin, *Journal of Financial and Quantitative Analysis*, forthcoming.

"The Sound of Silence" with Mohsen Saad, 2014, *The Financial Review* 49, 203-230.

“Informed Trading and Market Structure” with Charlie X. Cai, Robert S. Hudson and Kevin Keasey, *European Financial Management*, forthcoming.

“Herding and Speculation in the Crude Oil Market” with Celso Brunetti and Bahattin Büyüksahin, 2013, *The Energy Journal* 34, 83-97.

“Who Drove and Burst the Tech Bubble?” with John M. Griffin, Tao Shu and Selim Topaloglu, 2011, *Journal of Finance* 66, 1251-1290.

“Clearing House, Margin Requirements, and Systemic Risk” with Jorge A. Cruz Lopez and Christophe Pérignon, 2011, *Review of Futures Markets* 19, 39-54.

“The Role of Speculators during Periods of Financial Distress” with Naomi Boyd and Arkadiusz Nowak, 2011, *Journal of Alternative Investments* 14, 10-25.

"Effects of Central Bank Intervention on the Interbank Market during the Subprime Crisis" with Celso Brunetti and Mario di Filippo, 2011, *Review of Financial Studies* 24, 2053-2083.

“The Role of Speculators in the Crude Oil Futures Markets” with Bahattin Büyüksahin, 2011, *The Energy Journal* 32, 167-202.

“Why to Maturing Futures and Cash Prices Diverge for Agricultural Commodities?” with Nicole Aulerich and Raymond P.H. Fishe, 2011, *Journal of Futures Markets* 31, 503-533.

“Why are IPO Investors Net Buyers through Lead Underwriters?” with John M. Griffin and Selim Topaloglu, 2007, *Journal of Financial Economics* 85, 518-551.

“How New Entry in Options Markets affected Market Making and Trading Costs” with Patrick DeFontnouvelle and Raymond P.H. Fishe, 2005, *Journal of Investment Management* 3, 24-40.

“The Development of Secondary Market Liquidity for NYSE-Listed IPOs” with Shane A. Corwin and Marc L. Lipson, 2004, *Journal of Finance* 59, 2339-2374, Awarded Outstanding Paper in Financial Institutions at the 2002 Southern Finance Association Meeting.

“The Dynamics of Institutional and Individual Trading” with John M. Griffin and Selim Topaloglu, 2003, *Journal of Finance* 58, 2285-2320. Nominated for the Smith-Breeden Prize.

“The Behavior of Bid-Ask Spreads and Volume in Options Markets During the Competition for Listings in 1999” with Patrick de Fontnouvelle and Raymond P.H. Fishe, 2003, *Journal of Finance* 58, 2437-2463. Nominated for the Smith-Breeden Prize.

“Nasdaq Trading Halts: The Impact of Market Mechanisms on Prices, Trading Activity and Execution Costs” with William G. Christie and Shane A. Corwin, 2002, *Journal of Finance* 57, 1443-1478.

“The Initial Listing Decisions of Firms that Go Public” with Shane A. Corwin, 2001, *Financial Management* 30, 35-55.

“The Effect of Nasdaq Market Reform on Trading Costs and Depths” with Michael J. Barclay, William G. Christie, Eugene Kandel, and Paul H. Schultz, 1999, *Journal of Finance* 54, 1-34. Nominated for the Smith-Breeden Prize.

“The Trading Profits of SOES Bandits” with Paul H. Schultz, 1998, *Journal of Financial Economics* 50, 39-62.

“The Importance of Firm Quotes and Rapid Executions: Evidence from the January 1994 SOES Rules Change” with Paul H. Schultz, 1997, *Journal of Financial Economics* 45, 135-166.

“Why Did NASDAQ Market Makers Stop Avoiding Odd-Eighth Quotes?” with Paul H. Schultz and William G. Christie, 1994, *Journal of Finance* 49, 1841-1860.

Book Chapters/Articles in Books

“The Changing Structure of Energy Futures Markets” with Bahattin Büyüksahin, Michael S. Haigh, James A. Overdahl and Michel A. Robe, 2009, in *Finance et Valeurs*, A. Corhay, G. Hubner and A. Miller, editors, ULg Press, Belgium.

“Equity Market Derivatives” with L. Mick Swartz, 2009, in *Financial Derivatives* (Robert W. Kolb Series in Finance), Bob Kolb and Jim Overdahl, editors, John Wiley and Sons, Inc.

“Tick Size, Market Structure and Trading Costs” with William G. Christie and Eugene Kandel, 2008, in *Stock Market Liquidity: Implications for Market Microstructure and Asset Pricing*, Francois-Serge L’habitant and Greg N. Gregoriou, editors, John Wiley and Sons, Inc., 173-197.

Working Papers

“Interconnectedness in the Interbank Market” (formerly titled “The Breakdown of the Interbank Market during the Financial Crisis”) with Celso Brunetti, Shawn Mankad, and George Michailidis.

“CoMargin” with Jorge A. Cruz Lopez, Christophe Hurlin and Christophe Perignon.

“Funding Constraints and Liquidity Contagion in U.S. Equity and Treasury Markets” with Christof W. Stahel.

“The Impact of Herding on Futures Market Prices” with Naomi Boyd, Bahattin Büyüksahin and Michael S. Haigh.

“Fundamentals, Trader Activity and Derivative Pricing” with Bahattin Büyüksahin, Michael S. Haigh, James A. Overdahl and Michel A. Robe.

"Do Institutional Traders Predict Bull and Bear Markets?" with Celso Brunetti and Bahattin Büyüksahin.

“Trading Networks” with Lada Adamic, Celso Brunetti and Andrei Kirilenko.

“Off but Not Gone: A Study of Nasdaq Delistings” (formerly titled “From Pink Slips to Pink Sheets: Market Quality around Nasdaq Delisting”) with Venkatesh Panchapagesan and Ingrid M. Werner.

“Stepping Ahead of the Book” with Amy K. Edwards.

“Liquidity Risk, Investor Flux and Post-Earnings Announcement Drift” with Kirsten L. Anderson and Eric So.

“Investor Behavior Surrounding Earnings Announcements” with Kirsten L. Anderson and Selim Topaloglu.

Work-In-Progress

“Price Discovery in Crude Oil Futures Markets” with Bahattin Büyüksahin.

“The Long and Short of Dealer Profits” with Jay F. Coughenour.

Teaching Experience

Seminar, Empirical Finance (PhD), 2012

Financial Management (MSF), 2013

Introductory Managerial Finance (MBA), 2013
Investment Analysis (MBA), 2001-04, 2006
Portfolio Theory (MBA), 2010, 2012
Derivative Investments (MBA), 1996-97, 2005, 2010, 2012-13
Management of Financial Institutions (MBA), 1995-97
Student Managed Investment Fund, 2013-14
Options, Futures and Other Derivatives, 1994-97, 2005, 2012-13
Investments, 2001-06, 2010
Speculative Markets, 2010
Introductory Managerial Finance, 1997-99
Financial Institutions Management, 1997

Presentations

“Interconnectedness in the Interbank Market” (formerly “The Breakdown of the Interbank Market during the Financial Crisis”)
Presented at Babson College, Cornell University, George Mason University and the University of Hull.

“LME and Aluminum”
Presented to the Metals Service Center Institute.

“Funding Constraints and Liquidity Contagion in U.S. Equity and Treasury Markets”
Presented at Syracuse University.

"Do Institutional Traders Predict Bull and Bear Markets?"
Presented at the New York Accounting and Finance Symposium and Syracuse University.

“Speculation, Prices and Market Volatility”
Presented at the 2014 Canadian Economics Association, the University of Mississippi and the University of Delaware Economics Seminar.

“The Evolving Landscape for Derivative Regulation”
Presented at Fulbright Jaworski Oil and Gas Compliance Seminar, HEC Paris, NasdaqOMX, the Università Politecnica delle Marche, Ancona, Italy, the Vanderbilt University Conference on Regulatory Change in the Global Financial System, at Cornerstone Research and the Platts Oil Trading and Risk Management Forum.

“Effects of Central Bank Intervention on the Interbank Market during the Sub-Prime Crisis”
Presented at the Università Politecnica delle Marche, Ancona, Italy.

"Trading Networks"

Presented at American University, George Washington University, Rutgers University, Southern Methodist University, Syracuse University, Temple University, the University of Central Florida, the University of Missouri-Columbia, the University of Tennessee and Villanova University.

"Improving Market Transparency"

Presented at the 2009 CFTC Symposium for International Market Authorities.

"Abusive Conduct from an Economist's Perspective"

Presented at the 2009 CFTC Division of Enforcement International Regulators Conference.

"The Role of Speculators in the Crude Oil Futures Markets"

Presented at the NYSE/Euronext Amsterdam & Tinbergen Institute Workshop on Liquidity and Volatility in Today's Markets and the 2009 International Association of Energy Economists International Conference.

"Index Trading and Speculation in Commodity Futures Markets"

Presented at the CFTC Agricultural Forum, the American Agricultural Economics Association Meeting, the Mid-Atlantic Farm Credit Board of Directors annual meeting, the Council on Food, Agriculture and Resource Economics, the Washington Area Finance Association, the U.S.-India Financial and Economic Forum, the U.S. Department of State Bureau of Economic and Business Affairs, the 2008 CFTC Symposium for International Market Authorities, the USDA/World Bank Food Panel, the 2008 IOSCO Conference on Speculation and Volatility in Commodity Markets, the Canadian Securities Administration, the Energy Information Administration (Department of Energy), the 2009 NCCC-134 Meeting on Applied Commodity Price Analysis, Forecasting and Market Risk Management, the Kansas City Federal Reserve Panel on Agricultural Finance, the 2009 EIA Energy Conference, the American Petroleum Institute, the 2009 FIA Legal and Compliance Conference, HEC Paris, the 2009 Canadian Economics Association meeting and the 2011 InVivo Paris Conference on Speculation in Agriculture Markets.

"Increasing Internationalization of the Financial Markets"

Presented at the Chatham House, London

"Index Funds and Data Dissemination in Crude Oil Markets"

Presented at the 2008 International Energy Agency Expert Roundtable on Oil Price Formation and to the U. S. CFTC Energy Markets Advisory Committee.

“The Impact of Herding on Futures Market Prices”

Presented at the 2007 CFTC Symposium for International Market Authorities.

“Price Discovery in U.S. Natural Gas Futures Markets”

Presented to the U.S. CFTC.

“Market Growth, Trader Participation and Pricing in Energy Futures Markets”

Presented at the Arizona State University, the 2007 MIT Center for Energy and Environmental Policy Research Conference and Johns Hopkins University.

“Liquidity Risk, Investor Flux and Post-Earnings Announcement Drift”

Presented at the University of Toronto and the University of Arizona.

“The Sound of Silence”

Presented at the U.S. CFTC and University of Delaware Brown Bag seminar series.

“Off but Not Gone: A Study of Nasdaq Delistings” (formerly titled “From Pink Slips to Pink Sheets: Market Quality around Nasdaq Delisting”)

Presented at the University of Delaware, George Mason University and George Washington University.

“Why are IPO Investors Net Buyers through Lead Underwriters?”

Presented at American University, Case Western Reserve University, Drexel University, the University of Missouri – Columbia, Morgan State University and Temple University.

“Investor Behavior Surrounding Earnings Announcements”

Presented at the University of Delaware Brown Bag seminar series.

“Trading Behavior around the Rise and Fall of Nasdaq”

Presented at the University of Maryland and the University of Connecticut.

“The Effect of Decimals on Nasdaq Retail Trading”

Presented at the University of Delaware and 2002 Eastern Finance Association Meeting.

“The Development of Secondary Market Liquidity for NYSE-Listed IPOs”

Presented at Nasdaq, 2001 Financial Management Association Annual Meeting, 2002 Southern Finance Association Meeting, the University of Miami and the University of Delaware.

“Competition for Market Making in NYSE IPOs”

Presented at Nasdaq.

“Nasdaq Trading Halts: The Impact of Market Mechanisms on Prices, Trading Activity and Execution”

Presented at the 2000 Western Finance Association Annual Meeting, 2000 NBER Microstructure Conference, 2000 Financial Management Association Annual Meeting, Penn State University, the Nasdaq Stock Market, George Washington University and American University.

“The Initial Listing Decisions of Firms that Go Public”

Presented at the 1998 Financial Management Association Annual Meeting, the Nasdaq Stock Market, Syracuse University and Arizona State University.

“The Trading Profits of SOES Bandits”

Presented at the University of Georgia and the 1997 Financial Management Association Annual Meeting.

“The Importance of Firm Quotes and Rapid Executions: Evidence from the January 1994 SOES Rules Change”

Presented at The Ohio State University, University of Notre Dame and the 1997 American Finance Association Annual Meeting.

“Cost Components of the Bid-Ask Spread: An Intraday Analysis”

Presented at the 1994 Financial Management Association Annual Meeting, University of Arizona, University of Houston, University of Iowa, University of Miami, Michigan State University and University of Notre Dame.

Referee,

Applied Economics, The Accounting Review, Eastern Economic Journal, Financial Management, Financial Review, International Review of Financial Analysis, Journal of Accounting and Public Policy, Journal of Banking and Finance, Journal of Business, Journal of Corporate Finance, The Journal of Economics and Business, Journal of Finance, Journal of Financial and Quantitative Analysis, Journal of Financial Economics, Journal of Financial Markets, Journal of Futures Markets, Journal of Money, Credit and Banking, The Quarterly Review of Economics and Finance and Review of Financial Studies.

Director,

Eris Exchange, 2011-Present

Southern Finance Association, 2010-2013

Track Chair,

Markets and Microstructure, Financial Management Association 2002

Markets and Microstructure, Midwest Financial Management Association
2003

Conference Organizer,

Sovereign Wealth Funds (American University), 2014

Program Committee,

European Finance Association 2006-11, 2014-15

Financial Management Association 2002-10

Financial Management Association—Asia 2013-15

Midwest Finance Association 2014

Southern Finance Association 2008

Western Finance Association 2003-11, 2013-15

Session Chair,

Financial Management Association 2002, 2004-05

Southern Finance Association 2000, 2002, 2008

Eastern Finance Association 2002

Discussant,

Allied Social Sciences Association 2007

Canadian Economics Association 2014

Finance Down Under 2013-15

Financial Management Association 1996-97, 1999-2002, 2004-06

Notre Dame/Nasdaq Dealer Market Conferences 1999-2000

Ohio State Conference on Dealer Markets 1996

Southern Finance Association 2000, 2002, 2008

Stanford Program on Energy and Sustainable Development, 2014

Western Finance Association 2001, 2004

Washington Area Finance Association 2000, 2002, 2004

Member,

American Finance Association

Financial Management Association

Southern Finance Association

Western Finance Association

Advisor,

Lerner Finance Club (MBA) 2005-07

Syracuse Financial Management Association 2011-13

Other Work Experience

Copy Editor, *Journal of Finance*, 1992-93

MBA Advisor/Graduate Admissions Coordinator, University of Iowa College of Business Administration, 1988-1991

Executive Trainee/Distributor, MAY Corporation Venture Stores Division, 1988

Honors and Awards

Lerner College Outstanding Scholar Award, University of Delaware, 2008

Research Grants,

Institute for Financial Markets, 2010

Lerner College of Business and Economics, 2004, 2007

University of Delaware General University Research Grant, 2006

University of Delaware Department of Finance, 2005

University of Notre Dame Mendoza College of Business, 1996, 1998-99

Nominated for University of Delaware Lerner College Teaching Award, 2004,
2006

Nominated for University of Delaware Lerner College Advising Award, 2004

Cited as "Prominent Faculty" in 2008-10, 2012 Business Week Rankings of
Undergraduate Business Schools

Member, Beta Gamma Sigma

Appendix B

Materials Relied Upon

Legal Filings

Complaint for Injunctive and Other Equitable Relief and for Civil Monetary Penalties under the Commodity Exchange Act in *United States Commodity Futures Trading Commission vs. Donald R. Wilson and DRW Investments, LLC*, dated November 6, 2013.

Findings of Fact and Conclusions of Law in *Jefferies & Company, Inc. v. The NASDAQ OMX Group, Inc., International Derivatives Clearing Group, LLC, and International Derivatives Clearinghouse, LLC*, January 9, 2013, JEF-CFTC-476403-33.

Expert Reports, Exhibits and Corresponding Backup Materials

Expert report of Robert M. MacLavery Prepared at the Request Of Plaintiff United States Commodity Futures Trading Commission in *United States Commodity Futures Trading Commission vs. Donald R. Wilson and DRW Investments, LLC*, June 19, 2015.

Depositions and Corresponding Exhibit Materials

Deposition of Brian Vander Luitgaren, November 19, 2014.

Deposition of Craig Silberberg, December 03, 2014.

Deposition of Christopher Bury, May 29, 2015.

Deposition of Donald R. Wilson, April 02, 2013.

Deposition of Garry O'Connor, February 29, 2012.

Deposition of Garry O'Connor, September 18, 2012.

Deposition of Gerard Kopera, April 2, 2015.

Deposition of Michael K. Dundon, April 1, 2015.

Deposition of Robert Wasserman on Behalf of the CFTC, April 22, 2015.

CFTC Related Documentation

CFTC 1997 Annual Report.

CFTC, Code of Federal Regulations, §38.500 Core Principle 9, 17 C.F.R. §38.500, August 20, 2012.

CFTC, Core Principles and Other Requirements for Designated Contract Markets, 75 FR 80572-01 Proposed Rules, CFTC 17 CFR Parts 1, 16, and 38, RIN 3038-AD09, December 22, 2010.

CFTC, Core Principles and Other Requirements for Designated Contract Markets, 77 FR 36612-01 Rules and Regulations, CFTC 17 CFR Parts 1, 16, and 38, RIN 3038-AD09, June 19, 2012.

CFTC, Derivatives Clearing Organization General Provisions and Core Principles, Federal Register/Vol. 76, no. 216, CFTC 17 C.F.R Parts 1, 21, 39, and 140, RIN 3038-AC98, November 8, 2011.

CFTC, Significant Price Discovery Contracts on Exempt Commercial Markets; Final Rule, Federal Register/Vol. 74, No.54, CFTC 17 CFR Parts 15, 16, 17 et al., RIN 3038-AC76, March 23, 2009.

CFTC, Statement of Regulatory Priorities, 63 FR 61402-01, November 9, 1998.

CFTC, Written Testimony of Jeffrey Harris, Chief Economist, and John Fenton, Director of Market Surveillance Before the Subcommittee on General Farm Commodities and Risk management, Committee on Agriculture, united States House of Representatives, May 15, 2008.

Data Source and Analytical Software Providers

Brian Vander Luitgaren IDCH Activity Logs Produced by DRW on December 14, 2011 and February 6, 2012.

Bloomberg, L.P., Prices and Other Financial Data.

DRW-IDCG-0000001.xlsx and DRW-IDCG-0000003.xlsx.

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